SCIENCE TODAY AND TOMORROW

Teachers' Edition

Science Everywhere

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TEACHERS' MANUAL

for Science Everywhere

SCIENCE TODAY AND TOMORROW

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Ginn and Company
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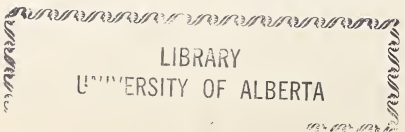

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Foreword

Science Today and Tomorrow

During the last twenty-five years, science has grown steadily in the elementary schools of the United States, Canada, and various countries of Europe, Asia, and Africa. This is no ordinary event, for new areas are not easily established in the elementary school, owing to the tremendous pressure of various groups to gain the attention of children.

Science in the elementary school has to a large extent been developed by classroom teachers. They have experimented with new activities, new content, and new methods. Many of them have constructed curriculum materials and developed reading materials in science for the elementary school. As a result of this work, instruction in science in the elementary school is uniquely designed for use by classroom teachers.

The new elementary-school program with its emphasis on science is a feasible program because it recognizes that the classroom teacher has many professional tasks; teaching science is but one of them. The teacher is a specialist in the education of children and not necessarily a specialist in science. There is no need for classroom teachers to feel any responsibility for specialized science tasks, such as naming all the objects in the environment, animate or inanimate, or serving as a field naturalist, a laboratory technician, or a general bureau of information.

It is evident that only those subjects that are in keeping with the basic purposes of the elementary school succeed in maintaining a permanent place in its curriculum. The American elementary school is a unique institution. It has been called at times "the great common school," in that it is the school for all the people. It was established by the early forefathers as the one institution that would be common to everyone, regardless of race, religion, economic status, and future occupation. It has become the basic institution dedicated to the task of the education of all people for citizenship in a democracy. A significant part of the success that science has had can be accounted for by the fact that elementary-school workers have been concerned that science be developed in the interests of *all* boys and girls. This pattern for science in public elementary education is being adopted by a number of democratic countries.

Science from the Developmental Point of View

Science in the education of children should be considered wholly from a developmental point of view. Recognition will then be given to the fact that children do not come to school for the first time at zero in science learning.

They have had a wide range of rich experience with physical and

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biological phenomena. They may have had a variety of experiences including those with friction, momentum, inertia, magnetism, static electricity, simple electric circuits, snow, ice, water, steam, melting, boiling, freezing, conditions necessary to certain living things, care of animals, seasonal change, the sun, the moon, stars, clouds, mirrors, magnifying glasses, evaporation, condensation, varieties of kinds of locomotion found in the animal world, animal mouths, ears, noses, coverings, balance with building blocks, wagons and tricycles, heat and cold, effects of seasonal change, different animal habitats in the community, solution of solids in liquids, molds, the large number of seeds produced by some plants, and so on. They may bring with them misconceptions and superstitions, or they may come to school with a good attitude, conducive to learning and the development of intelligent and resourceful behavior.

Many teachers of children find it useful to accept a point of view of dynamic psychology for understanding children. Their ideas may be stated simply in such words as these: A child lives in a dynamic universe which is new to him. He is challenged by his many experiences. This universe is filled with a great variety of objects. He is impressed by the events (phenomena) small and large occurring about him, such as rusting, rain, weathering rocks, electrical shocks, thunder, wind, and falling objects. He finds himself in normal circumstances tremendously stimulated and turns naturally to exploring and learning.

A young child is naturally egocentric. He is not to be condemned for being so; his egocentricity grows out of his great potentialities for ceaseless drive and for adjustment and understanding of his environment and himself. As a result of the great drives and yearnings, he feels inside himself a whole gamut of emotions which are to him discoveries about himself. He may display grief, irritability, anger, restlessness, impatience, and disappointment. Although such expressions are not to be condoned or encouraged in children, they are not to be considered in themselves evil, for out of these emotional drives have come many of the great constructive developments of mankind, such as democracy, better living conditions, religious freedom, and improved health.

A child is an energy system, and in all the universe we do not find its equal. It is remarkable that out of the use of his energy, a child is becoming intelligent in a universe filled with a vast variety of living and nonliving objects, an almost kaleidoscopic array of events and changes. Within his rapidly widening universe, the child attempts to identify himself and his inheritance. Viewing children from this dynamic point of view assists parents and teachers to understand that the drives of children, which are so frequently annoying to the adult, are potentially constructive traits.

A child learns about his environment whether he is taught science or not, although some of his learning may be negative in value. The kind of science learning considered in this Manual begins in the cradle. As a child begins to separate himself from his environment he begins to develop learnings based on these experiences. Parents and teacher must recognize that there may be learning about the environment even though a child is unable to state meanings in words. For instance, a child is experiencing something with the rattle he places in his mouth although he has no words with which to shape thought. He is learning something about the earth and its gravity as he pushes his weight against it in taking his first steps. Were the earth like a suspended rubber balloon that bounced away from him, or if the gravity were not constant and pulled him with greater force at some times than at others, he would develop a different set of attitudes and behavior. In considering science in the program of elementary education, it is well to conceive of science experiences as beginning with birth. In a real sense, the adjustment to the environment can be traced back to the prenatal stages.

In a very real sense, we might say that the potentialities of science are inside human beings. To make it more personal we may think of these potentialities as being in such human beings as ourselves—teachers and children in the classroom. This is true because science has grown out of a tremendous urge on the part of mankind through the long centuries to come to an understanding of the universe.

Man, from the remote past, has sought explanations for the things that happen in the world about him. The rainbow, birth, death, life, lightning, and other events challenged him. He frequently used great ingenuity and much fancy to develop explanations for the phenomena about him. The myths and legends of many peoples indicate men have felt that if they could understand the world about them they might know more about themselves, their origins and history. The fact that primitive people frequently associated their explanations with their religious beliefs demonstrates how important such explanations were to them. In fact, these explanations had much to do with man's adjustment to the environment. Sometimes man's explanations made him fearful and superstitious; at other times they filled him with confidence, calm, and resourcefulness.

According to the developmental point of view, the origin of science is in man's distant past. An implication of this for teachers in the elementary school is that science need not be thought of as something foreign to them or to the children they teach. Science as we know it today, with its discoveries and inventions, is the result of urges in men and women through the ages. We can see these same urges in children as

they follow their natural drives and as they attempt to secure adjustment and equilibrium in a dynamic universe. They use the senses of smelling, tasting, feeling, seeing, and hearing, the kinesthetic sense, imagination, curiosity, energy, irritability, restlessness, play response to external conditions, and other partly understood drives deep within their natures to project themselves into the areas of the environment. They depend upon impulse, fancy, creative activities, and logical thinking just as their ancestors did.

From the developmental point of view not all of science is difficult. On the contrary, from this point of view science is part of the earliest learnings of children. Furthermore, the technical, vocational, and specialized aspects of science have no function in elementary education. Elementary science is closely related to the experiences of children and to the kind of thinking they can do, so that teachers need have no fear of science. The teacher can learn the science that is needed while teaching science at any level in the elementary school.

The fear of science felt by some adults is not usually found in children. The adult may have been conditioned to a dislike of science in part by previous contacts with science instruction at high school and college levels, whereas children, having felt no such conditioning, are still following their natural impulses. Teachers can free themselves from their negative reactions if they will attempt to see the environment and science through the eyes of children. Encouraging children in a classroom to express themselves freely about their ideas of natural events has assisted many teachers to understand children and at the same time to gain a new look at the world for themselves.

Using Science in a Democracy

There has grown up a conviction that the free nations must remain strong if they are to remain free. There is also a realization that there is power in science, and therefore that science is an essential element in maintaining and improving the democratic way of life. It will not be enough to have a small portion of the population educated as scientists; to be truly strong, an entire nation must be conversant with science. To realize this goal, science must be placed in the curriculum as one of the fundamentals. Making a whole nation conversant with science is a task uniquely suited to the elementary school, since this is the institution of all the people. It is the institution which has in its enrollment not only the future scientists but laymen as well (everyone is a layman outside his special field).

Strength for free peoples is secured through the development of good

living conditions as well as military defense. Through the use of science man can do much to shape his own future, since science has tremendous potentialities for the improvement of living conditions for all.

The children now in the elementary schools will live in a world of tomorrow. Our boys and girls will live in a time of great decisions. They will need to make certain that science will be used for good and not for evil. They will need to determine how democracies can be kept secure. There will be great problems concerning the use of new and old sources of energy. Theirs will be the problems of wise utilization of natural resources, the distribution of new synthetics, medicines, and drugs, provision for health and well-being, development of materials from new sources, establishment and maintenance of research agencies dedicated to public welfare, the establishment of a balance of nature that will provide ample food and recreation for all, and the creation of a stable economy based on the natural resources and other problems to be solved, all within a democratic framework. Through all of this there will probably be a consideration of problems of international and world co-operation.

As we seek to determine what shall be the basis for our instruction in science in the education of children we find we must look to something more permanent than a mere teaching about objects. We make this decision because in a few decades we ourselves have witnessed a vast array of new inventions displace objects which once seemed permanent. Kerosene lamps have given way to electric lights in many places. We have observed the transition from telegraph to television. Our familiar world is in constant transition. So, although we may utilize objects in teaching children, we cannot base our curriculum on objects. We must look deeper for our basic purposes.

Some might say that our major purpose is giving children content. But the content of science, important as it is in the education of children, does not constitute the fundamental purpose of including science in the elementary curriculum. This is true, first, because our basic purpose must be in terms of children and society, and consistent with the dedication of the public elementary schools to the principles of democracy. Second, as we shall see later in this introduction, we must recognize that the content of science is not absolute; what we think is reliable information today may need revision tomorrow.

What we can be certain of is that boys and girls will need to be resourceful and democratic in the decades ahead if their and our way of life is to survive. Therefore, we are concerned with the development of resourceful and democratic behavior. If we succeed, we shall not need to be unduly concerned for the future, for with the development of

resourceful behavior in accordance with the high purposes of democracy, our boys and girls can use science to shape the future with complete confidence.

It is to be noted in this discussion that science is considered as a tool for humanity. There is no intent in the education of children to develop science for its own sake or to defend science as a vested interest. Only as science serves in the development of children and in the welfare of humanity can it be defended as essential in the education of elementary-school children.

It is most important that we recognize that boys and girls need to do much more than talk about science. If democracies are to preserve their way of life, there must be in their populations the ability to operate intelligently and resourcefully with the materials and energy of the universe to the best interest of mankind.

Social studies, however valuable they may be, are not sufficient in themselves to help children meet and solve the problems of today and tomorrow. Teachers and school systems are likely to miss the great contributions of science to children and through the children to the larger goals of democracy when they place science in the curriculum as a segment of the social studies. Science grows out of the tremendous urges of the human organism and does not have to be motivated through social studies. Many students of children think that science by its very nature is more challenging to young children than social studies. This is not to be interpreted as an argument against the social studies. It is, however, an appeal that curriculum workers thoroughly think through the concept that science is a part of the development of children. If properly guided, children can grow in intelligent and resourceful behavior just as they can grow physically if properly nourished.

Some have suggested that the primary purpose of science in the education of children is to develop "little scientists." Such an idea is not consistent with the fundamental purpose of the elementary school and the origin and nature of science in society. There should be no hero worship of scientists except in so far as an individual scientist deserves it. Democracy will be weakened if a society is created with a distinct scientific class. Scientists serve, but so do soldiers, senators, artists, carpenters, barbers, farmers, doctors, and everyone else. Scientists now and then outside their own special fields are somewhat naive, and at times exhibit traits of gullibility and dogmatism, thus violating the fundamentals of science. Scientists are human beings like other people. We should not set up the lives of scientists as ideals for children to follow, regardless of how much we may appreciate the contributions of science.

The Nature of Modern Science

In science we do not view knowledge as absolute. Any statement of science can be challenged, revised, or refuted with suitable data. There is no room for dogmatic attitudes. There can be no dictator for science.

Through science, man strives always for a better understanding of the world. Unfounded prejudices, opinions, gossip, rumor, astrology, myths, intuition, and superstition cannot be considered reliable sources.

Science is an active, dynamic field, constantly demanding willingness to make new observations, to repeat experiments, to consider new facts, and to challenge earlier conclusions. Science is far from a finished subject; in fact, it is likely that it is only in its beginnings. All the areas of science are undergoing changes as a result of continuous study. New ideas are being added and old ideas revised about stars, ventilation, living things, diseases, nutrition, and other areas of science.

Man learns through experiences by means of his senses. Science has produced new instruments, such as telescopes, microscopes, and others, that extend man's range of observation and experience. Nevertheless, to explain many happenings in nature, even everyday occurrences, is exceedingly difficult in spite of many new technical tools. So scientists have been forced to develop provisional explanations, or hypotheses, to guide them in further study of some things. But scientists must abandon any hypothesis as soon as it is found to be unsatisfactory. There is much that scientists have not satisfactorily explained. Many times a scientist must say he does not know even about problems within his own field of specialization, and even though he may by all rights be the world's leading authority on the problem involved.

Since man is continuously in the process of making new discoveries and revising his information, accuracy is not an exact status. This means that we do not teach a fact as though it must be true for all time. It indicates, also, that we cannot teach all the truth to a child about any single subject. We may, however, attempt to make certain in the classroom that the way in which a child learns is consistent with scientific attitudes.

We cannot hastily call an item correct or incorrect. Instead it is essential that in all our discussion, reading, experiments, and so on we determine what is the most reliable information at a given time. It may not be as serious a matter to be mistaken in the information we may have at any time, as to assume that there may be no need to secure new information on all important matters throughout our lives. It is also a serious matter to pass along information as if there were no question about its accuracy when we are not sure of its reliability. The nature of

modern science is thus entirely consistent with the idea that learning takes place through the continuous growth and development of large concepts. It also indicates how necessary it is to view education as a process which takes place from the cradle to the grave.

Accuracy is a direction toward which man in his best efforts strives. It is also a goal toward which teachers and children can move in teaching and learning; it calls for growth for both teachers and children. A child's ideas gained from science can be accurate in so far as they go, but as a child proceeds through the school his knowledge about any one subject increases in amount and detail. In other words, we may not be able to teach children all the reliable information in science about a given subject, but what we do teach can be consistent with what is reliable. Authoritative books such as those in the SCIENCE TODAY AND TOMORROW series can be most useful to both children and teachers in maintaining a high standard of accuracy and a sound development of attitudes.

Science and Behavior

This condensed description of the nature of science has been provided because it has many implications for the teacher and can provide him with a sense of security and adequacy in teaching children. The teacher has the right according to science to play an honest role in the classroom. He has a right to admit that he is learning; that he makes mistakes sometimes; that sometimes a child with a special interest and concentration may be learning faster than he is. In a real sense, the scientific method is a method of honesty, and neither teacher nor child should be penalized in any way for being honest. The learner should never be humiliated for the admission of ignorance. The implications of science for mental hygiene and human relations are profound.

It would be well for the teacher to consider the implications of science in the development of such behavior patterns as open-mindedness, critical-mindedness, and the avoidance of gullibility. There is no greater educational factor operating in the modern world than the attitudes that teachers and parents utilize while working and living with children.

In science it is important to state the source of one's comment in explaining a phenomenon, such as evaporation of water, hibernation of animals, erosion of soils, and so on. For instance, one might say, "I read an explanation in . . . ," or "It may be . . . ," or "My father said . . . ," or "On my way to school I saw . . . ," or "I think it might have been," or "I used my imagination," or "I think I am right," or "I can do an experiment to show . . ." This is preferable to giving such information as if the statements were unquestioned facts. We have

sometimes called this identifying the source of a comment. The teachers and children should develop the behavior pattern of identifying the source of a comment.

Both teachers and children have a right to use their imaginations, to speculate, to repeat information as long as they distinguish between reliable and unreliable information. Such a behavior pattern is in the direction of assuming responsibility for one's own speech. It is quite different from the behavior of gossip, loose talk, and rumor spreading.

This type of development should not be allowed to harm the good human relationships of children. Frequently children use parents' opinions as reliable information. It would be well for the teacher to handle such comments in a manner that will in no way decrease the child's respect for his parents. In a sense, the attitude of the teacher may be that we are glad to have what the parent has said, and indicate that further development of the statement is given in authoritative books. Perhaps the comment might be, "What do persons who spend their lives studying this kind of thing say?" Science instruction should be utilized to improve the human relationships of children, those of children with children, children with teachers, and children with parents.

It is obvious that the great behavior patterns growing out of science are not built in a finished manner in a day or a year or a decade. For instance, critical-mindedness and open-mindedness require time for development. Development of the patterns associated with resourceful, democratic behavior should be considered a continuous program throughout the elementary school.

There is considerable evidence that three great achievements of mankind—democracy, scientific method, and religious tolerance—developed contemporaneously and out of the same general struggles. An examination of these achievements will indicate that these three have much in common in basic meanings. In the opinion of many students, real science cannot exist outside a democracy.

The Content of Elementary Science

Almost everyone is impressed with the extensive nature of science; it has indeed grown tremendously in scope. No one can learn all of science in an entire lifetime. It is also obvious a teacher cannot teach it all. Only a very small portion of the total science will be taught to children, but that portion can be most important in the development of citizenship. The question of how much content of science is taught is not of nearly so great importance as is the question of what content of

science is taught and how it is taught. With the world situation as it is today, it is most important that the content and procedures of science suggested to teachers and children in such a series as SCIENCE TODAY AND TOMORROW be those designed for the preservation and advancement of democracy.

Because of the extensiveness of science, there has been a tendency to develop what might be called encyclopedic instruction. Under this method students have been required to learn wide areas of content. Comprehensive instruction has been developed about animate and inanimate objects and about topics in the environment, with little sensitivity on the part of curriculum makers as to the value of the content to the teacher and children involved. In the encyclopedic type of instruction the purposes of science in elementary education became lost in small content and busy work.

A traditional trend in nature study has been to make science instruction dependent upon an incident approach. If a child brings in an object, such as a rock, a feather, or a flower, or if he can relate an interesting experience, then there is instruction in this field about the object or incident. If there is no object or no incident, there is no science instruction in such classrooms.. Science becomes incidental and accidental in the classrooms of teachers holding to this point of view.

But science is no incident in the lives of children. In fact, it is and probably will continue to be one of the most dominating and decisive factors in their entire lives. Schools developing science on an incidental basis will not provide boys and girls with the education they need for the great decisions they must make for themselves, their country, and the world.

This is not to say that incidents have no place in teaching-learning situations. Natural incidents can be used as experiences for concept-formation and for the development of understanding of phenomena. But science with its profound and challenging ideas has a great contribution to make to the formation of concepts and important ideas. If our democracy is to survive, we must make certain that the potentialities of science in our way of life will be developed. This instruction must not be incidental.

Since the best information scientists have at any one time will need to be revised in keeping with future discoveries, a content of science in the elementary school cannot be considered as set and fixed for even a few years. There are, however, certain patterns for the universe which seem to persist as profound descriptive principles for all time, in spite of revisions and modifications that follow new discoveries. These patterns are described in the following statements:

a. The universe is very large.

b. The earth is very old.

c. Many changes are going on in the universe.

d. Living things are interdependent and interrelated.

e. Living things which are living today are the results of adaptations that have been made in the past.

f. There is a great variety among living things.

g. There is evidence of a tendency toward balance among the forces and living things.

For the sake of brevity, we can speak of these patterns as principles of space, time, change, interrelationships, variety, adaptations, and balance.

These patterns seem to be guide lines for instruction through the elementary school. A child can continue to grow along the lines of these great principles or patterns. The experiences an individual has throughout life can enrich his understanding of these principles. Man must recognize these patterns if he is to adapt his civilization to this universe. A knowledge of these basic patterns is necessary to the understanding of the world's problems and life's experiences in our modern democratic world.

The Large Patterns of the Universe as Guide Lines for Teaching-Learning

The Universe Is Very Large—Space

As man has studied the universe that surrounds the earth he has become impressed by the immensity of space. The earth which he thought was very large and the center of everything is small compared with many other objects in the universe. This earth is one of several bodies which revolve about a star known as the sun. The sun is one of millions of stars which compose a vast galaxy of bodies called the Milky Way. Man has learned that there are many other galaxies within range of the modern telescope.

While a complete understanding of the immensity of space is undoubtedly beyond the mental capacities of any one individual, it can become a guiding factor in the interpretation of the experiences of children at all levels. The young child may begin his growth in the understanding of space as he begins to associate with himself the rooms in his home and the yard or immediate vicinity about his home. Later, he learns the location of the nursery school or kindergarten when he is taken there by adults or by school bus. Still later, he goes to school by himself and learns where the homes of his relatives and friends are in

relation to his own home. As he travels to neighboring communities his world becomes larger. He may be intrigued by the observation that the sun and moon seem to follow him as he moves about.

A child's early contact with this pattern may merely teach him that the earth is a very big place compared with his familiar neighborhood. He may become acquainted with the appearances of the day and night sky. Later, his learning will reveal that the earth is very small in comparison with the stars and space. About the same time he will also learn that the stars are suns which are very, very far away. In later years he increases his understanding of the vastness of space by learning about the extent of the solar systems, the Milky Way Galaxy, radio stars, cosmic rays, the galaxies, the light year, and so on.

Any adult who has read modern astronomy, has attended lectures in this field, visited an observatory or planetarium, or considered the possibilities of space travel knows that his conception of space continues to change after childhood. There are new, challenging thoughts for all levels—the junior high school, senior high school, and college levels—and, for that matter, many new discoveries still to be made by the astronomer. Some comprehension of this conception is essential to an appreciation of the significance of science in its revolutionary effect on modern thought. It is important that children should be started properly along this path rather than allowed to absorb inaccurate and unscientific ideas of the universe and astronomical bodies and to grow up with earth-centered conceptions in an age of modern science.

The Earth Is Very Old—Time

The conception of the great age of the earth and of the universe has come to mankind as a revolutionary idea. Not only has it profoundly influenced scientific understanding, but it has altered man's attitude toward his own place and function in the universe. It was natural for primitive man to think that the earth had been formed just a short time before the advent of his people. Much of this primitive belief came down into modern times and still controls thought in scattered areas. Children in their early years may learn that soil is made from rocks, and through activities, observations, and experiences discover that the process of soil formation took a long time. They may also learn something about the forces which operate upon the earth to produce changes; that it was a long time before the earth became a suitable place for plants and animals; and that many kinds of animals have lived on the earth and have become extinct. These ideas furnish him useful content in constructing his understanding of the great age of the earth.

Children may have a variety of interesting experiences with earth forces: for example, they may examine pavements broken by water freezing in winter; feel rocks softened by the action of weathering; observe erosion after a rainstorm; note how plants keep soil from eroding; examine different kinds of soil with a magnifying glass.

Time is something to be learned. Children must learn the concepts of yesterday, today, and tomorrow; the meaning of a second, a minute, an hour, a week, a month, a season, and a year; the sequence of seasons; the varied lengths of life of living things. A tree may be several hundred years old, and on the other hand, a moth may live only a few days.

Time is relative to both children and adults. A half hour may be a long time waiting for a plane or train, but very short if we are playing. A year between birthdays can seem a long time, but it is short in terms of the centuries the Indians have lived in the Western Hemisphere. The teacher and the parent can greatly enlarge children's concepts of time.

In later work children may learn something about what has happened to the earth, the causes of natural features in various localities, the long ages of prehistoric life, the struggle of life for existence, the forces operating on the earth, and some of the changes that have taken place on the surface of the earth. This comprehension of the great age of the earth is essential to an appreciation of the antiquity of man and of man's attempts to build social institutions for his own welfare. The goal is not the memorizing of a chronological sequence of events, but rather an approach to the modern conception of time. These ideas reveal to man the importance of building his social and political structure with the thought that he may live on this planet for some time to come, provided he uses his intelligence to assure survival. These concepts are fundamental to building an understanding of what is intelligent utilization of natural and human resources. This understanding is necessary for man's planning for his own future.

This background to an appreciation of the modern concepts of time and change should tend to inhibit chauvinism; it should teach each pupil that all life existing on the earth today is the result of a long succession of living things—a development involving a vast number of individuals and extending back to the beginning of life on the earth.

The mountains, rivers, valleys, plains, seas, and other physical features that we think of in connection with a given nation and that often come to be revered by the people of that nation have not always been there as they are now. The surface of the earth has changed its appearance many times in the past and is constantly changing today.

As the result of a long series of experiments in the art of living, man has become a dominant force in nature, and we have a right to feel a

pride in the achievement of all mankind. It must be emphasized in our instruction that this achievement is restricted to no one race or nationality.

Changes Occur Continuously in the Universe—Change

The conception of change permeates all fields of knowledge, and man must consider these changes if he is to operate intelligently with natural forces. Modern geology reveals that our physical environment does not remain constant, that the history of the earth is a story of change—change in climate, in topography, and in the succession of living things.

The conception of change is manifest not only in geological history but in living things, as, for example, the changes produced by birth, growth, age, and death. There are also changes produced by the biological principles of struggle for existence; and these cannot be ignored by man in his striving to adapt the world to his needs. Then there are the changes produced by energy and movement. Astronomical bodies are seen to have changed position and character through cycles of time. The scientist learns to look for change in his explanation of phenomena; the layman must expect change as a condition of everyday life; the student of social studies and the citizen must anticipate change in the political, social, and economic structure. Information concerning changes produced by physical and chemical phenomena, developed in terms of children's own experiences, can be introduced during early school years and continued through later levels.

Children see water disappear from a dish by evaporation. They pick up rocks which have weathered so much that the rock disintegrates into small pieces in their hands. They see the changes in the sky, in the weather, and in seasons.

Illustrations of change include such phenomena as rusting of iron, melting of ice, boiling of water, weathering of rocks, variations of weather and of seasons, and innovations produced by man's discoveries and inventions.

School windows should be utilized more fully for the study of the succession of changes due to weather, to the seasons, to the time of day, and man's activities in relation to these changes. Brief excursions around the school ground will provide varied experiences depending on the region. The children may see frozen, muddy, and dry soil; the growth of plants; and a variety of plant structure, such as roots, stems, flowers, and seeds. An outdoor thermometer may reveal temperature changes. Art work can be utilized in the study of changes.

A community of living things never remains in a strictly static

condition. Children can observe the changes in a weed patch near the school, in a thicket, or in a garden. There is a continual shifting caused by weather, seasonal change, and just ordinary life and growth within the cycle of new life, maturing, and death. All around children are evidences of change.

There is no exception to the occurrences of change even when man is involved. Natural forces are always present and working in an environment. Perhaps man can never control the natural forces. Rather he must learn to work intelligently with these natural forces to bring about changes which are advantageous to his best interest.

In addition, there are the great changes brought about by man's inventions and man's discoveries. Of course, children are not so aware of the significance of these changes as adults. However, the school must prepare children to meet change, for the next generation may need to be prepared for even greater changes than those met by the present generation of adults.

Man has lived through revolutionary changes in his social living because of the introduction of new forms of energy and of ways to utilize that energy. The discovery of fire, the introduction of animals to carry man's burdens, the steam engine, the electric generator, and the internal-combustion engine greatly changed man's social and economic conditions. The utilization of atomic energy is bringing and will continue to bring tremendous changes. Children should gain a feeling of confidence in the fact that they are not the first of the human race to witness revolutionary changes in energy. Furthermore, it might be well for us to know how man's discoveries of new forms of energy have brought about great potential supplies of energy for everyone. The advances in the field of agriculture and soil culture may have significant impacts on the future course of world events.

Changes brought about in a community also may be significant. What did the country look like before the earliest settlers came in? What changes have been brought about by man?

There are only about a hundred elements which enter into combinations and form the multitude of substances about us. Chemists find that some of these elements combine in so many different ways that to date they have been able to make but a small proportion of all the possible combinations. Chemists are learning to build out of cheap sources substances which in their natural states have been very rare. They have also learned how to make new substances, such as new drugs, insecticides, medicines, plastics, synthetics, and so on. In this way, science contributes greatly to an improved health, finer recreation, and higher standard of living.

Life Is Adapted to the Environment—Adaptation

Adaptation is a pattern which permeates the entire realm of living things, for wherever there is life there is adaptation. This is a conception of great significance in the modern world. Indeed, man's problem today is to adapt his social, economic, and political structure to the conditions of the environment and his own needs. In the early grades children can learn something about the homes of some animals and their adaptation to life in various places. They can be introduced to the idea that animals' structures have become modified to fit their environment. Later they can learn how plants and animals, including man, are adapted to seasonal changes. The study of prehistoric life is a story of adaptation, and can be supplemented by a study of how animals are protected against their enemies, how animals take care of their young, and how plants continue to live on the earth. Man adapts himself through community life. The advantages and disadvantages of this form of adaptation, along with a study of solitary animals, may be considered on intermediate levels. As the child matures the scope of his concept of adaptation is further broadened through a study of prehistoric modifications, of the weapons which animals use, and of the struggle for existence.

The conception of this pattern, like the conceptions previously outlined, may influence an individual at all levels of his development. It may modify the child's interpretation of simple observations of the effect of seasonal change on plants and animals. It may give substance to the youth's understanding of the structural variations of living things, and to his consideration of problems of public welfare. It may determine the adult's participation in politics and in public forums. The scientist finds much that remains to be discovered concerning adaptation. The significance of this conception in the social studies can scarcely be over-emphasized.

Some of the more general facts involved in understanding the concept of adaptation are the relationships of living things to temperature, water, food, light, gravity, and certain gases found in the atmosphere; the effect of some of the limitations of these conditions upon life; the narrow range in these conditions on the earth as compared with those found in the universe as a whole; the adaptations imposed upon plants and animals that live under these conditions; the prolificness of life; and the interchange of energy and substance between plants and animals and between the physical environment and living things. Through experimentation, discussion, and reading, children learn that living organisms need light, oxygen, nitrogen, carbon dioxide, heat, water, and other conditions in order to exist and to produce young. When some of these things are scarce or too abundant, life may suffer.

The implication for international understanding is that man frequently is limited by the physical conditions of the environment to which he adjusts himself. Some people must live in inhospitable places, such as swamps, deserts, and arctic regions. These people must utilize the materials that are available for shelter, food, and clothing. It is not surprising, therefore, to find among the peoples of the earth a wide variety of customs. Many of these customs which seem foolish to others may be the results of the experiences of many generations in a given environment and may be necessary to the survival of that people.

International co-operation has become a necessary adjustment on the part of mankind if our culture is to survive.

In science studies in the elementary school, children have an opportunity to realize that man is only one of a multitude of living things, and that, like these other things, he has survived because he has made adjustments and adaptations to the environment.

The Variations of Living and Nonliving Things—Variety

On the earth there are wide varieties of climate exhibiting differences in mean temperature, in the range of temperature, in the length of the growing season, in the amount of rainfall and its seasonal distribution, as well as differences in exposure, in slope, in drainage, in elevation, and in soil. These factors create many kinds of environments and require adaptations to these environments. All around us we see in nature a variety of forms, differences in structure, sizes, habits, and life histories of plants and animals. They range from the ultramicroscopic organisms to the gigantic forms of the redwoods and whales. The life span of some living things is very short, while that of others covers several hundred years.

When we see how many different kinds of living things there are, it is not surprising to find that there are also so many different kinds of people. Man has wandered about the world for thousands of years, living in many habitats widely separated from each other. We should expect, therefore, to find different races, languages, and customs, but a concept that science may teach is their interdependence despite their differences.

No two living things are exactly alike, although they may be of the same species. We cannot, therefore, judge all people of any nation on the basis of one or two we may have known.

Variation is manifested in the physical world as well as in the biological. There are many systems of organization in the physical world—the atom, the element, the molecule, the compound, the substance, the planet, the solar system, the galaxy. There are many kinds of minerals,

soils, and rocks. There are only around one hundred elements, but there are thousands of different compounds. There is variety in the manifestations of energy. Man, too, tends to develop variety of forms in his inventions, discoveries, engineering, and arts.

Children should become acquainted with this theme by being introduced to the range and scope of certain obvious characteristics in the physical and biological aspects of nature. Instruction should be chiefly concerned with the theme rather than with mere identification of animate and inanimate objects.

Each child has two parents. Each parent brings to the child a diverse inherited background. When we consider that this means for each child four grandparents, eight great-grandparents, and so on, the tremendous potentialities working for variation in the human race become apparent. When to this observation we add the fact that each child has a different environment, the tremendous variations found in children in any classroom are understandable. Every individual is a result of success through a long span of years in that each of his ancestors is the result of two parents reaching maturity in spite of sometimes hazardous conditions.

The concept of individuality, that each individual is unique and different from all other individuals, is a part of the larger pattern of variety. Williams,[1] a biochemist, has recommended that we should start teaching children in the kindergarten that they possess individuality. His recommendations merit serious consideration by elementary-school workers. They point to one way in which science can contribute to mental hygiene. Each individual has a right to be different. He should not be amazed to learn he is superior to some of his classmates in some ways and inferior to others in other abilities. This pattern can be used to develop a feeling for the dignity of the individual, a feeling so important in a democracy.

Following are some of the aspects of variations that are illustrative of those found in the environment of children:

Changes that take place in the out-of-doors.

The many different kinds of animals.

The variety of animal noses, eyes, tails, mouths, coverings, legs.

The variety in prehistoric animals.

The different ways in which animals move about.

The differences in animal homes, such as those on the desert, in the arctic, in swamps, underground, in fresh water, on the seashore, in the ocean depths, in the forest, in the meadow, in trees.

[1]Roger J. Williams, *Free and Unequal: The Biological Basis of Individual Liberty* (Austin, University of Texas Press, 1953), p. 177.

The variety in locomotion, food-getting, breathing, and protection of animals.

Different ways in which animals grow up.

The many different kinds of plants, such as those that develop from spores, those that develop from seeds, those that are annuals, those that are biennials, those that are perennials.

The animals that are social, and those that are solitary.

The animals that are cold-blooded, and those that are warm-blooded.

Interdependence of Living Things—Interrelationship

A theme which is practically universal in character is interrelationship. We see the significance of interrelationships as an integrating theme in many of the forces operating on the earth, for example, in the description of astronomical bodies, weather, and other physical phenomena; in the interdependence and interrelation of living things to each other and, in turn, to their physical environment; in the causes of ill health; and in the relation of pests and parasites to economic loss in the agricultural world.

Space does not permit a full discussion of how the idea of interrelationships in physical and biological phenomena may be developed. In the early years children gain experiences which lead to an understanding that some plants and animals in the garden are harmful. In later work they learn the value of certain other plants and animals and what people are doing to protect them. Attention should be focused in later elementary-school work on the problem of conservation and on preparing pupils for a more comprehensive study of the biological principles involved in the struggle for existence, in the balance of nature, and in the interdependence of life. Some of the relationships of scientific discoveries and inventions to man's progress and welfare should be considered. Man does not live to himself alone. He lives in a world of interdependencies and interrelationships. He is dependent upon earthworms and plants for the fertility of the soil. He is dependent upon birds to keep insects in check. He needs snakes, owls, hawks, and other animals to keep rats and mice in check. Spiders serve to control the number of insects. An animal which seems rather insignificant to us may play an important role in the development of conditions suitable to man.

The interdependence and interrelationships of living things to other living things and of living things to the physical environment is basic to the understanding of social issues. Physical and biological forces do not recognize national borders. A wind blowing in one country may be due to world-wide atmospheric conditions and the pressure of air in regions

within the borders of other nations. Animals do not necessarily stop at national borders unless those borders are natural barriers, and even then certain animals are known to cross many such barriers.

In science the earth must be considered commonly as an entity; a disturbance in the physical or biological world in one part of the earth may have significance to many other parts. In a community a fire in one section is the concern of the entire community. A disease or a pest in one section of the world may become the concern of all peoples. Nations, therefore, should learn to work together in an intelligent way for the welfare of all peoples of the earth.

The natural resources of a country, such as soil, oil, coal, gas, forests, and pastures, are the result of natural forces operating for millions of years. People have not created them, but they frequently waste them through carelessness and mismanagement. Man can waste in a generation or two what has been the result of titanic natural forces operating over long periods of time.

Man, if he is to remain civilized, must disturb the original balance of nature, for only savagery can exist where man does not attempt to make changes. But it is man's task to use the natural processes and resources in such a way that he secures what he needs for a high standard of living without hazarding the welfare of future generations. Man need not return to savagery nor disregard natural resources; he now has science to use in planning for the years ahead. It is incumbent upon the public schools to develop a generation with ability to meet its problems, both personal and social, with intelligence, co-operation, and resourcefulness. This calls for an appreciation of the interdependence of living things, and of the interrelations of living things and the physical forces and materials.

Balance and Imbalance—The Interplay of Forces

As one observes the many events or phenomena in his environment one is impressed by the dynamic flow of events and the energy involved in them. If one could be an observer over centuries, one would be aware of the titanic forces in operation; but seen one day at a time over the short span of a human lifetime these forces often pass unrecognized. Some, such as evaporation, seem small; yet scattered over the face of the earth, evaporation is tremendous and results finally in rain, snow, dew, frost, weathering, erosion, floods, blizzards, and other events.

There seem to be tendencies toward equilibrium and balance in the operation of forces. In a normal atom it is thought the positive electrical charges balance the negative electrical charges. It is thought that

a static electrical charge is the result of an imbalance in these electrical charges. The shock we feel or the lightning flash we see is the resulting establishment of equilibrium of these charges. Even the thunder can be thought of as a clap caused by air rushing in where the air was expanded by the heat of lightning.

We have already spoken about the balance of nature. Man has been ruthless at times with this balance and has experienced economic loss from the resulting dust bowls, soil erosion, waste of resources, epidemics, plagues, and pests.

There are forces operating also in the structure of the earth. It is thought by some geologists that in maintaining balance these forces have caused the formation of mountains, continents, and oceans. We witness earthquakes and volcanic eruptions as a part of the balancing of the earth's structures.

It should be kept in mind that the sun is a great source of energy and that it shines on the earth all the time. It shines on the other side of the earth while we are having night. It shines when it is cloudy, although there are clouds between us and the sun. The sun then is like a great solar engine which furnishes energy for green plants to grow and make food, for water to evaporate, and for the movements of air currents or wind and of ocean waves. The movements caused by the sun's energy are checked and modified by the earth's gravity, its rotation, and to some extent by friction. There is a tremendous interplay and interaction of the forces in the universe.

Wherever we look we witness the operation of forces and the many evidences of balance. In our own efforts to maintain balance and equilibrium, we also experience the operation of natural forces in and on our own bodies. Many psychologists explain learning at all levels as a process of attempting to gain intellectual balance in the face of a new situation, a problem, or a challenge.

Conservation as a Pattern for Behavior—Developing Responsibility for Our Environment

As children develop a better understanding of the basic patterns of the universe they also may acquire more intelligent behavior with reference to natural resources, including human resources.

Some courses of study help to establish undesirable kinds of behavior, as when children are encouraged to develop collections which in turn can rob the environment. Sometimes they are instructed to bring to school collections of leaves, twigs, flowers, rocks, minerals, and bird nests.

We need to develop in children a feeling of responsibility for the

environment. Conservation, or intelligent use of natural resources, consists of a kind of behavior as well as a body of content. Before moving objects, animate or inanimate, out of the environment and into the classroom, there are many major considerations which the children may discuss. To whom does the object belong? Do I have the right to take it to school? Do I disturb the environment if I remove this object from it? Am I destroying the natural beauty of the environment by removing this? Is the study I am going to make of the object one which merits its removal from the environment? Should I plan to return the object to the environment as soon as the study is completed? Can this object be studied properly if it is removed from the environment? Can I care for it properly in the classroom? If it is alive, does it have a chance to live in the classroom? Am I prepared to give it the care it needs to survive? One should keep in mind that living things are usually found in an environment to which they are more or less well adapted.

Developing Behavior Consistent with Health, Economy, and Safety

Many schools are now integrating health entirely with science and the social studies. Science provides the necessary background for the teaching of health information and the development of good health habits; therefore, a program of science in terms of problems and meanings should offer opportunity for the integration of science and health.

The relation between science and economy has too long been neglected. Because of his own ignorance of the operation of biological and physical principles, man is at present beset by a host of problems concerning international economy. Recent projects in a number of countries are helping to solve these economic problems in local environments by re-establishing in the natural forces a balance in favor of man's interests and welfare.

The relation of science to the economic problems of man is well exemplified in his struggle with pests. Man has carelessly introduced exotic plants and animals into almost all regions of the world. Many of these transplanted plants and animals, unchecked by their natural enemies and competitors, have multiplied so rapidly that they have brought havoc to the economic life of the nation. Control comes not alone from the work of fact-finding public or private scientific agencies, but also from the intelligent co-operation of the entire population. Much can be done to secure this intelligent co-operation through an integrated program of education in the public schools. Mankind cannot afford to have another generation ignorant of the elementary biological principles of nature.

Another similar problem is to find ways to prevent loss of soil through erosion. In almost any section of the world we can find examples of the terrific loss of natural resources resulting from the lack of soil conservation. Creating an awareness of this problem in order to bring about intelligent individual and community action concerning it is no small part of science in the elementary-school program.

Many species of our indigenous plants and animals have become extinct because of man's ruthlessness and ignorance. Still others are in danger of being destroyed. Man cannot continue to be ignorant of the web of life in which he is by nature involved. The elementary school, as the tool of the common people, should work toward developing a generation concerned with the wise utilization of natural beauty and resources.

We cannot fully anticipate the environment of the future. New inventions may eliminate present hazards and create new ones, making it impossible for us to develop a code of conduct in safety instruction which will be functional for an entire life span. It may be well for us, then, in safety instruction, to place more emphasis upon scientific principles which are basic to safe conduct. Children at all levels should be encouraged to enter into planning with the teacher for safety on all excursions, including the short excursion, even though it may be only to the edge of the school grounds.

Consideration should be given to what one should do in case of fire or other disaster so that the behavior is automatic. Classroom teachers and parents can have a powerful influence over the destiny of whole regions and nations by developing in children a willingness and ability to base their conduct and behavior upon sound information. Safety education, as one aspect of the goals of conservation, can well be integrated into the development of responsibility for one's own behavior and for the environment.

A Variety of Procedures

The teacher should look to a variety of procedures in teaching science. It might be well to avoid dropping into routine methods. Discussion, instructional excursions, observations, experiments, reading, use of visual aids, group work, and planning all play a part in the teaching-learning situations in science education. The teacher should consider her own interests, tempo, and rhythm along with those of the children. It is important that the teacher be happy with the procedures. It is well for the teacher to be present as a participant in all the procedures. He should be a learner, for good teaching in science involves learning.

If there is one term that can be used to specify the kind of instruc-

tion appropriate to all phases of science teaching in the elementary school, it is "developmental." In this case it is developmental from the point of view of children and teacher, both as learners. It means the instruction develops, using the experiences and knowledge children may have or that can be provided for them. It is developmental in that children may participate in the development of the planning for the use of experiences, experiments, discussion, and authentic materials to provide solutions to problems. The new learning is made acceptable to the children by the nature of its development in instruction. Children are given time to internalize new learning, integrating it with their experiences and ideas. It is important in this development to provide opportunities for an idea to be tossed about in the thinking of a group, to be tested through simple experimentation, if appropriate, or through observation, to be talked about at home, and to be checked against authoritative books.

In any consideration of teaching methods, the primary concern in elementary education is what kinds of boys and girls are being developed. All of us need to be cautious that our procedures do not become devices and ends in themselves. Therefore, evaluation should be an integral part of instruction rather than something done at the end of a period of instruction.

At all times in teaching it is well for the teacher to know at what point the children are in a given development. In this Manual suggestions are given the teacher as to ways in which he can secure this information. It is well also to find out how the children think, that is, the type of thought structure they have. Such questions as "What do you think?" "Do you think so? Why?" "Why do you say that?" "How would you get the information?" "Do you think that is information we should accept?" will give the teacher evidence as to how children think and where they are in their development.

Regardless of how the instruction at any point is initiated, vital teaching recognizes the concepts children may have on a subject or problem. So it is well for the teacher to provide opportunities for them to express their ideas, however incomplete or inaccurate, in order that misconceptions may be brought into the open. It is most important that they be allowed to express themselves without the fear of censure or ridicule, although at times there can be the enjoyment of childish humor and fun without personal damage.

Very frequently children's concepts have originality and imagination. Their concepts also provide opportunities for evaluation of preceding work and reveal the kind of instruction needed for the clarification of ideas. The authors of this series have profound respect for the natural

ideas developed by children. Every child needs an adult who will sympathetically and intelligently listen to him. If such a person could be provided for more children, we would need fewer corrective institutions.

Studying Children while Teaching Science

Teachers will find their teaching enriched if they will study children as they teach. Science with its challenging content and its rich contribution to the attitudes and behavior of both adults and children offers unique opportunities for the study of children.

The greatest concern in studying children is not how much information children have secured, important as that may be. Rather, the main emphasis should be on what kind of boys and girls we have. What kind of thinking do they do? What are their outlooks upon the world? Are these outlooks constructive and democratic? Do the children think for themselves? Are they developing good ways of thinking? Are they learning to be resourceful?

At all times teachers should be alert to the kinds of behavior changes that children are making. The teacher may ask: Are the children developing dogmatic attitudes, or are they willing to consider new ideas? Are they tending to accept every idea they hear without hesitation? Do they look for further evidence before drawing conclusions? Are they learning to use authoritative books? Do they report on out-of-school experiences in a wholesome way? Do they propose explanations? Are they learning to plan? Will they work with others?

In this kind of study it must be recognized that behavior may reflect the home and the general background of the children. A dogmatic parent may cause a child to be gullible.

It should be kept in mind that it is the behavior in which a child has had some degree of freedom of choice which is the most useful for evaluation. The closely worded or directed question of the quiz program and the rigid recitation have little significance in evaluating behavior. In a sense it is the spontaneous behavior of children—the proposal of something to do, the inquiry, the choice of language in indicating open-mindedness, the critical-mindedness, poise, resourcefulness, the challenge of a statement, the willingness to consider new ideas and to take on new duties, the use of old learning in new situations and learning—which is useful in evaluation. All of this seems to favor a type of discussion in science instruction which allows for freedom of expression and thinking.

It is recognized in this that teachers need to study children as individuals and as groups and from a total, rounded-out point of view of

education. The contention here is that science with its profound meanings offers unique potentialities in studying children from this view. Children should not be evaluated as if the development in behavior relating to science were isolated from all other aspects of their lives. Science, as the interpretation of the environment, should be thought of as an intrinsic part of the life of children in the modern world, a part that may be an important factor in building desirable behavior.

A Dynamic Education for Children

The preservation and advancement of democracy depends to no small extent on the behavior patterns developed in children. We do not know what the future will be. In a sense we must educate children for uncertainty, This does not imply that we need be pessimistic about the problems these children will face in the future. Rather, we can be confident that if we assist them to develop democratic and resourceful behavior, they will make their own future.

It is the contention here that the outlook of children toward their environment and universe is the very core of the development of a resourceful adjustment to the future. While incidents play an important part in making learnings meaningful, science should not be incidental in the lives of children. Instruction limited to talking about science and a description of objects and events is not in keeping with the dynamic urges of children and will not serve to help them cope with the problems of today and tomorrow.

There is a need for a positive and dynamic program for children, one which develops a feeling on the part of children of being needed by our democracy, in times of peace as well as war. Children are needed not alone for their own nation but to assume responsibility for work toward a better world.

There may be opportunities for children and teacher to work to improve conditions in the classroom, in the school, on the school grounds, and in the community. In this way, they can see how science is used.

Science will continue to play an important role in the lives of our children. It is a powerful tool which can be used for good or evil; and children, the adults of the future, will have to decide which way it shall be used.

It is most important to the success of our way of life that children have a favorable attitude toward science. Science should not seem foreign or exotic to them. Science viewed as the result of the age-old drive of man to adjust himself to his environment and to maintain his own equilibrium in the welter of biological and physical forces carries

with it a larger point of view than a purely vocational one. Science is the result of man's experience and logical thinking through the centuries. Science, like democracy or the mother tongue, belongs to all who wish to make use of it. Children should be made to feel that science belongs to everyone.

Science instruction should be a pleasant experience for both teachers and children. Teachers should feel relaxed with children while teaching it. Interest in science should be maintained at all levels. The instruction should be freed of assignments involving busy work and meaningless drudgery. Exhaustive and overly specialized units should be avoided.

Boys and girls must learn to handle and to experiment intelligently with the forces and materials of the universe. Unintelligent tampering and carelessness bring disease, ugliness, waste of natural resources, unemployment, poverty, war, and widespread unhappiness. Children must develop a poised, well-balanced, yet realistic outlook upon the modern world. They must learn that by working resourcefully and intelligently they can create their own world.

GERALD S. CRAIG

Purpose and Plan of *Science Everywhere*

A child begins very early in life to be aware of his surroundings. He seeks to explain the happenings in his environment as evidenced by such questions as "Why does it rain?" "Where does the sun go at night?" "What makes a motor run?" "How do rocks get in the earth?" A child has an active curiosity. *Science Everywhere* provides a source of information which a child may use in endeavoring to satisfy this natural curiosity. It will help him find out more about the world in which he lives.

Science Everywhere is the third book in the series SCIENCE TODAY AND TOMORROW. It is designed to meet the needs and to suit the abilities and interests of children eight and nine years of age. The science experiences suggested in *Science Everywhere* have been developed and used with children of this age.

The content of science in the elementary school as developed in the SCIENCE TODAY AND TOMORROW series is based upon the development of six basic concepts, namely, *time, space, change, variety, adaptation,* and *interrelationships.* Each of these concepts is developed as it affects the lives of children. *Time* and *space* are developed in the chapters "Changes All About You," "The Earth You Live On," and "The Sky Above You." *Change* is particularly emphasized in "Changes All About You." It is dealt with also in the chapters "The Air Around You" and "Using Water Wisely." *Adaptations* and *interrelationships* are discussed in the chapters "How Animals Get Food," "How Animals Escape from Enemies," "The Air Around You," and "Using Water Wisely." The theme of *variety,* however, is the concept most emphasized in *Science Everywhere.* The variety in living and nonliving objects is pointed out throughout the entire book. It is highlighted especially in "How Animals Are Different," "How Animals Get Food," "How Animals Escape from Enemies," and "The Earth You Live On."

The concept of variety has wide application. The variety found among living and nonliving things is accepted as commonplace. People, for example, are expected to be different, not only in different lands but also in a single community. They vary in appearance, mode of living, economic status, in their likes and dislikes.

One expects also to find differences among other living organisms, both plant and animal. There is great variety, for example, in the sizes of plants and animals, in their life spans, their ways of self-preservation, their means of getting food, and their anatomy.

There is variety, too, among nonliving things. They vary in mode of origin, color, texture, size, hardness, and weight.

Geographic regions vary greatly, as is pointed out in the chapter "The

Earth You Live On." Some places are warm; others are cool. Some are wet; others are dry. There are forested regions and grassy regions. There are high mountains and rolling plains.

Variety among people, other living organisms, nonliving things, geographic regions, and in weather is the rule rather than the exception. Children will learn to respect these differences if they understand them. It is one of the purposes of *Science Everywhere* to help children recognize the great variety which exists among living and nonliving things.

This Manual is intended as a guide to using *Science Everywhere.* Additional information about each chapter in the children's textbook is supplied to aid the teacher in presenting the material to third-grade children. No teacher need feel inadequate in teaching elementary science. The day is past when it was the teacher's duty to be the "know-all" in the classroom. Today the teacher need not feel uneasy in having to say "I don't know." But acknowledging a lack of information is not enough. The next step is to suggest "Let us see what we can find out." The gratifying experience of solving a problem together begins when teacher and children work together with a common interest and objective, each contributing in accordance with his own capacity. In some instances, a child may make a contribution in the form of relating an experience or by asking a question which stimulates further thinking, or the teacher may present information from a source inaccessible to the class. The Manual for *Science Everywhere* is designed in a manner that enables a teacher to enrich his own science background as he teaches and to learn along with the children. Answers to questions asked in the textbook are supplied either there or in the Manual.

In order to derive the greatest benefit from the Manual, it is suggested that you read the material in it pertaining to the corresponding chapter of *Science Everywhere* before you teach that chapter. In the Manual you will find: (1) an introductory discussion of the basic concept that is presented in the chapter; (2) a list of science meanings to be developed for the children; (3) a section giving additional information for the teacher; (4) ways of working with children that will aid them in comprehending the science meanings; (5) a list of materials and equipment needed to carry out science experiences suggested in the children's book and in the Manual; (6) suggestions for additional experiences and activities; (7) ways you and the children may evaluate your experiences with the information presented; and (8) lists of books, films, and filmstrips that may be used to supplement the information provided in other ways.

Introductory Discussion

It is the purpose of this section in each chapter of the Manual to introduce the topic to be studied in the corresponding chapter of *Science Everywhere*. It is a brief orientation for the teacher, giving her the main concepts that follow in the chapter. This introductory statement also gives the scope of the material which is presented in a given chapter. For example, in the introductory discussion of Chapter I, the teacher is told that this chapter deals with the large concept of variety; that variety among animals is to be emphasized here; that size, shape, and body covering are some of the ways in which animals differ; and that the emphasis in this chapter is to be on the variety of sizes and shapes among animals. In other words, this section of the Manual provides a quick reference to the content, scope, and emphasis of the chapter.

Science Meanings to Be Developed

A list of science meanings to be developed follows the introductory discussion in each chapter of the Manual. This list summarizes the learning elements to be covered in the chapter. They are written as nearly as possible in the language of children, although they will not be used directly with children. These science meanings serve as a guide to the teacher as she develops with her class some of the larger principles of time, space, change, variety, adaptation, and interrelationships which are discussed at length in the Foreword of this Manual.

Information for the Teacher

In this section, information is given that is pertinent to the topic discussed in the corresponding textbook chapter. Much more information is included here than will be used by the children. This section is designed to provide the teacher with a background of information which will aid her in presenting the textbook material in the framework of its larger concepts. Also, it provides information in an available, easily accessible form for beginning teachers and others with little science teaching experience, so that no teacher need feel inadequate in presenting the material of *Science Everywhere* to her children. Teachers are urged to extend their knowledge in each of the areas of information in *Science Everywhere* by utilizing the sources of additional information given in the Bibliography for the Teacher at the end of each chapter in this Manual.

Ways of Working with Children

There are numerous acceptable ways of working with children in the presentation and development of science ideas. Throughout this Manual ways to help children build science concepts are suggested. Among these ways of working with children are: discussions, reading, experiences and activities, instructional excursions, recording information, and the use of audio-visual materials.

Discussion · A discussion period may accomplish many worth-while things. It may prove valuable in determining the accuracy of the information children possess, in clarifying old ideas, in contributing new ideas, and in evaluating material presented. Often discussions are useful in raising questions, offering thoughtful "guesses" (hypotheses), and for checking facts and opinions. Discussions frequently offer clues to starting points for learning the science concepts to be developed.

Discussions may be motivated in many ways. The illustrations in the textbook and others brought into the classroom by you or the children often serve this purpose. Discussions may be started by questions asked either by you or by a pupil. Following are examples of such questions:

What large animals have you seen?

Can you think of any animals that get their food while flying through the air? What do you think the food might be?

Can you see why a butterfly needs to have a tongue that is like a thin straw?

Discussions sometimes start from differences of opinion among children in the group. In these instances, discussions may lead on to the next step, namely, looking for facts to substantiate opinions. Questions like these may start the search:

What makes you think that?
How do you know?
Where did you hear that?
How can we find out?
How do you know that is true?
How may we be sure about this?

It is wise to allow children ample time for expressing their ideas in a discussion period. They should feel free to express their thoughts, whether correct or not, without fear of criticism or censure. In such a permissive atmosphere a free interchange of ideas can take place.

Reading · Children receive new information from many sources in their environment. Reading materials are one important source. Reading is an essential part of the scientific method. You are encouraged to make

books available to which children may turn for the information they are seeking. *Science Everywhere* is one such book which presents carefully checked and accurate information for children, written with a vocabulary easily understood by most eight- and nine-year-olds.

M. W. Lembach, University Park School, Denver, Colorado

Opportunities to pursue individual interests are provided when a variety of books are available for unscheduled reading periods.

A number of other selected books may be kept on a library table or shelf in the classroom, and the children encouraged to seek answers to their questions there. The Manual lists at the end of each chapter books which are appropriate for use as references by third-grade children. The books listed are of varying difficulty so that a wide range of reading abilities may be served.

For children in the third grade, it is well to have the reading of *Science Everywhere* guided by the teacher. She may need to guide them in focusing their thinking on certain main science concepts being developed on a given page. In each chapter of the Manual the list of science meanings to be developed will be helpful in pointing out these concepts. The teacher will also have in mind some of the science words to be introduced and will frequently be able to acquaint children with them through a discussion of the illustrations in the textbook. After children have a "speaking acquaintance" with science words and have discussed them in relation to the illustrations or their own experiences, these words have more meaning for them when seen on the printed page.

Science materials should be read for specific purposes. You may ask children to read to secure information, to check ideas, as a means of sharing information, to follow directions for an activity or an experiment, to check observations, and to clarify a point under discussion. Reading can supply ideas for new experiences that a teacher and her class may share as they explore the book. Reading is also valuable in bringing

into the classroom vicarious experiences in which children might otherwise be unable to participate. And reading can be exploratory or in the nature of orientation to the environment.

The children's books listed at the end of each chapter in the Manual may be used as such supplementary sources of information by the children. They are of varying difficulty and so may well meet the individual differences in children's reading abilities.

Experiences and Activities · Although use of *Science Everywhere* necessarily involves reading skills, it is more than a reading textbook. It is also a doing book. It is designed to stimulate children to think, to look carefully, to try out things, to make hypotheses, and to test these hypotheses. You will note that the textbook contains many questions which should stimulate discussions, and make further reading, observing, and experimenting more valuable.

The actual manipulation of objects is often a valuable learning experience. Children may feel the lightness of a piece of pumice, the rough texture of a sponge, the "pull" of a magnet. They may see the many things which make up various soils by examining soil samples at firsthand. They may learn more graphically about electric circuits by actually wiring a circuit, using a dry cell, wire, and light bulb. They may watch the phenomenon of evaporation by wetting the chalkboard and watching the water disappear. Whenever possible, children should have firsthand experiences with science.

The Manual suggests additional experiences and activities which implement the science meanings developed in each chapter of the textbook. You will wish to point out the relationship between the reading children do and the experiments they carry out. Often the reading raises questions or problems to which children wish answers. Experimenting and trying out things is one way of finding answers to these questions. The activities and experiences listed in both the textbook and the Manual are simple enough in most instances for children to carry out alone. Through them, children may add to their fund of firsthand experiences with the materials and ideas of elementary science.

Instructional Excursions · Excursions into the community also furnish children with valuable experiences which they cannot obtain within the classroom or school itself. Preplanning is an important part of an observation trip or excursion. In this planning both you and the children should take part. For example, within the classroom preceding the excursion the group will want to:

Discuss: Have we time in our program to take such a trip?
Will it help us to know more about the topic we are studying?

Is such a trip worth the effort and preparation involved?
How do we conduct ourselves on a trip?

Decide: What should we do to prepare for the trip?
What do we want to find out on this trip?
What things shall we look for on the trip?

Arrange: Transportation
Permissions
Adequate supervision

During the trip you will want to watch for incidents that provide clues to attitudes regarding the excursion. For example:

Do the children seem aware of the things they are to observe, or is this just a "joy ride"?
Do they ask questions pertaining to the subject of the trip?

When you are back in the classroom, evaluate the trip in terms of the reasons for going. You will want to know:

Was the trip worth while in the opinion of the children?
Did the trip help to answer the questions raised?
What further activities might be undertaken as a result of the trip?

Recording Information · There are various types of information that are worth while to record as children study different areas of science. As a result of discussions, there are often items which need to be recorded for future reference. Sometimes a *list* is the best way to do this.

Charts are another way of recording information. For example, charts might be used to record:

a. The steps followed in carrying out an experiment
b. The results of an experiment
c. The hypotheses offered by children as solutions to a problem prior to experimentation
d. The care of various kinds of equipment, such as magnets, electrical equipment, aquaria, etc.
e. The illustration of some scientific principle, such as the flow of electricity along a closed circuit, the areas of attraction around the poles of a magnet, the movement of water in and out of the air

Construction and *art activities* also furnish a means of recording information. Children may draw or paint pictures to show various things they have learned about animals with strange shapes, for example, or ways animals defend themselves, or the different ways in which animals get food, or the colors in a beam of sunlight, or the different types of clouds.

M. W. Lembach, University Park School, Denver, Colorado

Selecting pictures and other information for a chart or bulletin-board display helps children summarize their learnings.

Children may also make models or three-dimensional constructions. Such activities that would be useful might include making:

a. A plant box
b. A model to show the relationship of the sun, moon, and earth
c. A model to show some of the earth's topographic features, such as hills, canyons, mountains, and coast lines

Bulletin-board displays serve as visual aids, as research activities, and also have value as summarizing activities. The preparation of the displays may be considered as additional experiences and activities, but the information they provide is recorded in a more or less permanent way for easy reference by children. Collections of various types often lend themselves to bulletin-board display. Here are suggestions for pertinent displays:

a. Different kinds of insulators
b. Different kinds of conductors
c. Maps of trips taken by the class

d. Local soil samples in cellophane bags
e. Different kinds of seeds

One purpose served by these records is that the information is made easily accessible for reference. As children continue to learn more about science they may refer to their charts, lists, or displays for various reasons. They may wish to review, to verify, to check again, to change ideas in view of new information, or to summarize ideas. Recorded material may be used in any or all of these ways.

Using Audio-Visual Materials · Not all children learn equally well through the same channels. Some children are ear-minded and remember best the things which they hear. Other children are eye-minded and learn more readily through visual impressions. The illustrations in the textbook are a primary visual aid to the reader. They should prove valuable in reaching all children, but especially those who are visual-minded. Often a picture has more meaning than a printed page for the child who finds reading difficult. The illustrations in *Science Everywhere* are designed as an integral part of the science program presented in the book. They are an extension and outgrowth of the text in a visual form, and serve to meet individual needs by presenting the material in a form easily understood by many children.

Bulletin-board displays, maps, charts, pictures, models, collections of various sorts, and three-dimensional materials such as aquaria and terraria are valuable as visual aids. These media serve to present science ideas in various forms and by their variety serve to meet the varied needs of the different children working with them.

Films and filmstrips also furnish visual aids to learning. Listed at the end of each chapter of the Manual are films and filmstrips which may be used to help make clearer the science meanings presented in the text. They may be used as a motivation for the study of an area of science. They are useful in the presentation of additional information. They may also be used to check the accuracy of some of the ideas and opinions expressed by children about certain phenomena.

A discussion preceding the showing of films and filmstrips helps children to know what to look for. This procedure makes it important that you preview the films before they are viewed by children. In this way you not only can determine the suitability of the filmed material but also can plan more effectively for the preliminary discussion of it. Discussions following the showing are equally important to make sure that the children's interpretations of what they have seen are accurate. As a result of the post-discussions, you may find that the children will benefit from a second or even a third showing to clarify some points.

Filmstrips have certain advantages over films. With filmstrips as much time as is needed may be taken to discuss the picture in each frame. One may proceed forward and then move backward one frame or half a dozen frames in order to recall a point, clarify an idea, or make a comparison. This increased flexibility has won much support for filmstrips from many teachers.

Lists of appropriate films and filmstrips are given at the end of each chapter of the Manual. Distributors and rental agencies are listed in the Appendix. Further information concerning these visual aids may be obtained by writing the film sources. Many state and municipal departments of education, museums, and libraries also have films and filmstrips which are available to schools. If the catalogues of these agencies near you are not now in your school you can obtain them on request.

The opaque projector is another visual aid used by many schools. With this instrument, small pictures, even those of postcard size, may be projected on a screen and enlarged so that they are easily seen by all the children in a room. Small maps and pictures in books may also be projected in this manner. Thus the individual contributions of the children may be shared with the whole class.

Tape recordings are teaching aids which assist the ear-minded child to grasp new ideas. "Tapes for Teaching" libraries are now maintained by many state departments of education and by some cities. A catalogue of available tapes can be obtained from the Department of Audio-Visual Instruction of the National Education Association. (See page 154.)

Materials and Equipment

The materials and equipment needed for the experiences and activities suggested are listed in each chapter of the Manual. It is the intent of the authors to keep the materials for carrying out experiences and activities in elementary science as simple and familiar to children as possible. For the most part, the materials suggested can be found in the classroom, in the children's homes, or elsewhere in the community.

Additional Experiences and Activities

Through reading and discussion of topics in *Science Everywhere*, children usually become interested in knowing more about them and other related topics. It is indeed hoped that new interests will develop as an outgrowth of their study. To help children in this enlargement of their interests, information, and understanding, the Manual provides additional experiences and activities paralleling each chapter of the textbook.

Some of the more able children may work out these activities as independent projects, and report their findings to the rest of the group.

A book, a map, and a globe provide three avenues of learning about our earth.

M. W. Lembach, University Park School, Denver, Colorado

Other children who have some difficulty with reading may find an outlet in manipulating science materials and gaining understanding through firsthand experiences. These additional experiences may be carried on by small groups working to check hypotheses or opinions, to gain more information, or to clarify a disputed point. A teacher may also wish to use some of the experiences to motivate interest.

Evaluation

Each chapter in the Manual includes an important section labeled "Evaluation." Although this section appears at the end of the chapter, evaluation does not always take place at the end of an activity. Evaluation is not limited to any one spot in the sequence of study. Some evaluation may come spontaneously from the children or you or both as an activity proceeds. It may come when a group of children are working together on a co-operative project as a problem arises. In such instances, the work may be temporarily set aside as the group examine their procedures and try to determine what the next step shall be.

Evaluation is more than the testing of facts covered in an area of

study. A child may memorize facts and still be unable to understand concepts or to make generalizations. True evaluation lies in determining the changes in thinking, attitudes, and behavior of a child. His understanding of a science concept may be revealed by such questions as: Does he recognize a problem when he meets one? Does he suggest ways to solve that problem? Does he make "guesses" or hypotheses? Does he apply old learning to new situations? Does he make statements or ask questions which show that he has thought about the problem?

Through evaluation it is possible to determine where you and the children have succeeded and where the results have been unsatisfactory. It serves as an indicator pointing in the direction of the next step.

The purpose of science in the elementary school is to encourage behavior consistent with the needs of a scientific age. This behavior is characterized by (1) a questioning attitude which is satisfied only when all available information has been secured; (2) resourcefulness in meeting new and changing situations; (3) thoughtfulness in the wise utilization of resources with concern for future needs; (4) and willingness to test and check ideas, and seek scientific answers to phenomena and problems. In other words, the success of science in the elementary school program may be measured in terms of the opportunities it provides for the development of scientific attitudes and methods as patterns of behavior.

Preceding the Manual material discussed in this introduction is the Foreword, which will serve as an important guide in understanding the purposes and aims of science in the elementary school. Here Dr. Gerald S. Craig presents important information which will be useful to you in helping children understand many of the aspects of science in the world around them.

The Vocabulary List of *Science Everywhere*

Science Everywhere follows the book *Science Around You* in the series entitled SCIENCE TODAY AND TOMORROW. It is designed for easy reading by pupils who have reached the third-grade level. The total vocabulary of this book is 817 words. Of these, 581 are introduced in *Science Around You* or occur in the second-year program of the GINN BASIC READING SERIES. These 581 words are assumed to be known to children in the third grade.

Science Everywhere also uses 236 new words necessary to the development of science concepts. The 107 starred words in the list below are found in the third readers of the GINN BASIC READING SERIES.

No more than four new words are introduced on any page, and each

word is used three times or more. Variants are counted as new words except when they are formed by adding *s, 's, es, ed, ing, er, est, ly,* and *y,* doubling the final consonant, and changing *y* to *i* before endings. Also not counted as new are words formed by adding the prefix *a* to known words, possessive forms of known words, and contractions. Compounds are not counted as new when each part is a known word, nor are words which are part of known compounds.

The new words are listed below by pages. The words assumed to be known are listed alphabetically.

New Words in Science Everywhere

4 . . .
5 scales
shells*
6 enjoy*
chickens
7 list
teacher*
write*
read*
8 magnifying
9 scientists
whale*
10 grownup
person
seems*
11 hundred*
feet*
measure*
12 float
weigh*
fifty
tons
13 giraffe*
neck*
danger*
meal
14 bison
elk
antlers
15 prairie*
inches*
mud*
worms
16 hummingbird*
miles*
17 branch*
spider*
webs
18 ants
19 marks*
between*
20 shapes
stems
thin*
stars*
21 . . .
22 strange*
cookies*
arms*
23 pattern
carefully
breathes*
24 lizard
sharp*
pins
porcupine
25 slug
body*
useful*
dragonfly
26 middle*
loop
27 barnacle
fastens*
life*
sponge
28 sizes
twigs
29 remember*
page
30 . . .
31 smell*
hunt*
wild*
themselves*
32 swallows*
insects*
33 wolves
coyotes*
woodchuck*
34 claws*
swish
35 trunk*
pelican
36 sucking
nectar
tongue*
straw*
37 teeth*
38 escape
enemies*
39 . . .
40 quail
bushes
among*
41 . . .
42 close*
snails
oysters
43 quills
hooks*
hurt*
44 fight*
hoofs
sting*
45 . . .
46 . . .
47 magic*
48 bath*
drank*
shone*
disappeared
49 blackboard
streak
faded
50 skates
brownish
full*
51 clips
comb
pennies*
tacks
52 cubes
refrigerator
filled*
hours*
53 . . .
54 campfire
coal
ashes
55 decaying
humus
die
56 soap*
turpentine
57 minutes*
58 fit
59 tadpole
60 bloom
61 month*
62 tools*
Jane*
doll*
63 crayon*
set*
radiator
cooking
64 . . .
65 . . .
66 bar
steel*
67 bent
68 . . .
69 hang*
70 magnetized
scissors

71 knitting
needle*
72 compass
directions
means*
73 points*
toward*
74 . . .
75 act*
76 . . .
77 cell
socket
pathway
electric
78 complete
screw
binding
posts*
79 . . .
80 switch
tin
81 second*
82 . . .
83 television
toaster
84 become*
85 . . .
86 . . .
87 bottom*
deeper*
88 spaces
89 . . .
90 pumice
squeeze
91 sinks
balloon
92 gases
oxygen
important*
vapor
93 aquarium
94 . . .
95 fog*
touches*
96 . . .
97 pebble
98 . . .
99 desert
shade
100 beach*
101 bare
102 damp
103 stream
104 island*
visit*
plains
105 differences
106 interesting*
sights*
107 . . .
108 spreads
valleys*
109 whole*
110 class
solid
111 Atlantic
globe
Pacific
make-believe
112 America*
113 flag*
114 crossing
115 perhaps*
116 . . .
117 clear*
118 order
119 . . .
120 farther*
121 fuel
122 glow
123 . . .
124 beam
125 rainbow
scatters
prism
126 drawing*
127 . . .
128 pleasant*
129 . . .
130 reflects
mirror
131 dim
132 game*
133 temperature
134 wisely*
135 . . .
136 tanks*
137 dam
138 . . .
139 Sally's
140 twelve*
flood
141 . . .
142 Paul's
crops
143 . . .
144 cattle*
145 . . .
146 . . .
147 . . .
148 banks*
149 careless
garbage
150 creek
151 . . .
152 . . .
153 . . .
154 . . .
155 . . .
156 . . .
157 . . .

Words Assumed to Be Known

a
about
above
across
after
afternoon
again
air
airplane
all
almost
alone
along
always
am
an
and
Andy
animals
Ann
another
any
apple
are
around
as
ask
at
attracts
away
baby
back
ball
barking
barn
be
bean
bears
beautiful
because
been
before
bell
below
Ben
beside
best
better
Betty
big
Bill
birds
birthday
blew
block
blow
blue
boats
book
both
box
boys
bread
break
bright
bring
brooks
brought
brown
bubbles
builds
bulb
bumped
burning
bus
but
butterfly
buzz
by
cake

called
came
can
candle
car
care
carpet
cat
catch
caterpillar
change
children
chipmunks
circus
city
clean
clinkety
clothes
cloudy
coat
cold
colors
come
cool
cork
corn
corner
could
count
country
covered
cows
crumbs
cup
cutting
darker
David
day
dead
deer
Dick
did
different
dirty
dish
dissolve
ditches
do
dog
dollar
donkey
door
down
drink
dropped
dry
ducks
dust
each
ears
early
earth
easily
east
eat
eggs
eight
electricity
elephant
else
empty
end
enough
evaporated
even
ever
every
experiment
eyes
face
fall
family
far
farm
fastest
fat
Father
feathers
feed
feel
fence
few
field
find
fine
fingers
finished
fire
first
fisher
five
flat
flew
floor
flower
fluffy
fly
follow
food
for
forest
forth
found
four
fox
Fred
freezing
friend
frog
from
fruit
fun
fur
furnace
garden
get
girls
give
glass
go
goat
gone
good
got
grasses
gray
great
green
grew
ground
grows
guess
had
hammer
hands
happen
hard
has
hat
have
he
head
hear
heard
heat
heavy
held
help
her
here
hide
high
hill
his
hold
hole
home
hop
horned
horse
hot
houses
how
hungry
I
ice
if
in
iron
is
it
Jack
jars
Jean
Jerry
Joe
jumping
just
keep
kinds
kitten
know
lake
land
large
last
late
lay
leak
learning
leaves
left
legs
less
letter
light
like
lions
little
lived
log
longer

look
losing
lost
loud
low
made
magnets
make
man
many
map
marble
Mary
matter
may
me
meadow
melting
men
might
Mike
milk
moon
more
morning
most
Mother
mountains
mouse
mouth
move
much
must
my
nail
name
nearest
need
neighbor
nest
never
new
next
night
no
noisy
north
nose
not
nothing
now
ocean
of
off
often
old
on
once
one
only
open
or
other
our
out
over
owl
own
paint
pan
papers
park
part
Patsy
people
pet
pick
picnics
picture
piece
pile
pipes
pitcher
place
plants
play
poles
ponds
pool
pour
pretty
puddles
pull
pumped
puppy
push
put
queer
quickly
rabbit
radio
rain
ranches
reach
really
reason
record
red
rest
rides
right
rings
rivers
roar
rocks
rolls
room
round
rubbed
run
rusting
safe
said
sail
salt
same
sand
Sandy
saw
say
school
sea
see
seeds
seen
seven
shadows
shall
she
sheep
shining
ships
shoe
shore
short
should
show
side
sign
silver
sits
six
sky
slowly
small
snow
so
soft
soil
some
soon
sound
south
spend
splash
spoon
spotted
sprinkler
squirrels
stand
start
stay
sticks
still
stood
stop
store
story
stove
straight
streets
strikes
string
strong
such
sugar
suited
summer
sun
supper
surprising
Susan
sweet
swim
swings
table
tail
taking
talk
tall
tell
than
that
the
their
them
then
there
thermometer
these
they
things

think
this
three
through
times
tiny
tip
to
together
too
took
top
town
toy
train
travel
trees
trip
try
turkeys
turns
turtle
two
under
until
up
us
use
vacuum cleaner
very
wait
walks
want
warm
was
washed
watches
waters
waves
way
we
weather
well
went
were
west
wet
what
wheat
when
where
which
while
white
who
why
will
wind
window
wings
winter
wire
wish
with
wolf
wonderful
woods
works
world
would
yard
year
yellow
yes
you
young
your

I

How Animals Are Different

Variety is one of the large basic concepts of elementary science. There is infinite variety in the animal world. Some animals, such as whales and elephants, are very large. Other animals are minute organisms which must be viewed through high-powered microscopes in order to be visible at all. In between these two extremes there are animals in many size gradations.

Animals vary not only in size but in their shapes, body coverings, and habitats. Usually these differences among animals are adaptations to conditions within their environment which enable them to survive in their particular habitats. For example, the long legs and long neck of a giraffe enable it to get its food, which grows at the tops of high trees, and to survey its surroundings so that it can more easily escape from its enemies.

The first chapter in *Science Everywhere* discusses two of the many ways in which animals differ, namely size and shape.

Science Meanings to Be Developed

Nearly all children, whether in a city, suburban, or rural environment, have an opportunity to have some experience with animals. For a city child, the experience may consist of a visit to the zoo, where he can see unusual animals. He may see also the various birds and other small animals that live in a city park. Or he may have a pet goldfish or turtle at home.

A child living in a smaller town or in the suburbs of a city may have more opportunities to observe animals. He may have a pet dog, cat, rabbit, hamster, or canary for whose care he assumes the responsibility. He usually has more opportunities to go for walks in the woods and fields than does a city child. On these walks he may see animals different from his pets and different from those in the city park or zoo. He may see wild animals in their natural environment.

A child living in a rural environment has still a different contact with animals and different opportunities for observing them. Often farm animals, such as sheep, cattle, and chickens, are the source of the family's livelihood, and it is often the task of rural children to help care

for them. Consequently, many rural children have much information about the specific differences among some animals.

It is the purpose of the chapter "How Animals Are Different" to help children gain certain specific science meanings and to develop broader understandings about differences among animals. The following science meanings are emphasized in this chapter:

There are many different kinds of animals. Animals vary in their sizes, shapes, and body coverings.

Animals may be seen in many places. Usually several different animals are found in each place or habitat.

Some animals are very large; others are very small. Whales are the largest animals we know about. Even the young of some animals are very large.

Animals may be large in different ways. Some are long; some are massive; some are tall.

The height of a giraffe helps it to survive.

Small animals vary in their appearance and habitats.

Some animals are tiny even when full grown.

Animals vary in their shapes. Some resemble twigs, flowers, or other objects because of their shapes.

Some animals can change their shapes.

Some animals stay in one place nearly all their lives.

Information for the Teacher

Large animals discussed in the first chapter of *Science Everywhere* include a blue whale, elephant, giraffe, bison, and elk. Different types of bigness are pointed out. Some animals are long; some are tall; others are massive. In writing about these large animals, the authors have endeavored to describe their sizes in terms which have meaning for eight- and nine-year-olds and to make comparisons which children of this age group can visualize.

Some of the smaller animals also are discussed. In selecting those to be included in this chapter, the authors chose small animals which would be familiar to most third-grade youngsters, rather than bizarre and exotic species. Also, animals were chosen from a variety of habitats rather than from just one so that more children might be able to identify some of the animals as ones they have seen near their homes. The small animals included in this chapter are prairie dog, mud turtle, hummingbird, field mouse, earthworm, ant, and fruit fly.

The second way in which animals are different as discussed in this chapter is in their shapes. Here again the authors chose animals which

are usually familiar to eight- and nine-year-olds. The strange shapes of many animals are evidences of adaptations that have helped animals to survive. For example, the walking stick looks like a twig; the praying mantis, like a green stem. Sea anemones look like flowers; sand dollars, as the name implies, resemble pieces of money. These resemblances provide a protecting camouflage. The horned lizard, porcupine, garden slug, dragonfly, measuring worm, rock barnacle, and sponge all have odd shapes. All of these animals depend in some measure upon their shapes as a means of survival. Although their shapes may seem strange to us, they help each of these animals to be better suited to the place in which it lives.

Most animals are suited to their habitats or they would not have survived in the struggle for existence. In any community of animals or plants there is great competition for the necessities of life. Animals compete for food, water, and a place to live. The animals that survive are usually those that adapt most readily to their environment and are in the closest harmony with their surroundings.

A frog, for example, is well suited to its habitat in a pond or stream. Its mottled, greenish color blends well with its surroundings of green plants, greenish-appearing water, and shadows. Its powerful legs are useful in escaping from its enemies both on land and in the water. The webbed feet of a frog further aid it in locomotion. A frog's eyes are protruding and are raised above its head. This adaptation enables a frog to be submerged except for its eyes, which can remain above water level while it becomes almost invisible.

Frogs feed largely upon worms and insects that are readily found in the frog's immediate environment. The green frog shown in the textbook belongs to the aquatic group. A wet habitat is essential for it.

When winter comes the insect population dies or migrates and the water of the pond or stream in which a frog lives begins to freeze. Thus its food supply is cut off. Under these adverse conditions the frog digs into the soft mud of the stream bank or pond bottom well below the frost line. Here it remains during the cold months of the year. When the sun melts the ice and warms the water, the frog emerges from the mud and begins life for another year.

Ways of Working with Children

Since animals are high on the list of children's interests, enlisting the eager participation of your children in the reading and discussion of the first chapter of *Science Everywhere* will not be difficult. You might begin by finding out how many animals they can recall

having seen during their summer trips, vacations at lakes or woods, or excursions to zoos or parks. Or a child's new pet which has caught the interest of his friends may center the group's attention on animals they would like to have as pets, or that they have never seen as pets. Or you might wish to take one of the study trips suggested on page 25 before beginning the chapter instead of using it as a summary experience. Throughout the children's work with this section of *Science Everywhere* you will wish to help them observe the ways animals are different and the interrelationships between the variations and environments.

Pages 5–7 · Many Kinds of Animals

In the large picture on pages 4 and 5 many different animals are shown. The chapter may be introduced through a discussion of the animals the children see in the illustration and by considering the questions suggested on page 5. Encourage the children in your class to discuss the ways in which these animals differ from each other. For example, you may suggest such questions as: How are the homes of these animals different? In what different ways do they move about? How are their body coverings different? Which of these animals have you seen near your home? Have you had any of these animals as a pet?

It is the intention of the authors to include on page 6 the different environments in which children live, such as the city, the suburbs or a small town, and a rural community. Thus each child may identify himself with some situation described in the textbook. Here again, the children should be encouraged to talk about their experiences with animals. Their discussions may furnish clues to a starting point for the development of the information in this chapter.

The recording of information gained by the children is often a worthwhile activity. Making lists, noting and recording changes, preparing reports, and making charts are examples of recording activities. Preparation of a list as a record is suggested on page 7 of *Science Everywhere*. Charts can be the extension and outgrowth of lists. On one chart may be written all the animals which the children in the class have seen. Two other charts may emerge as the children refine their thinking. One might be titled "The Largest Animals We Have Seen" and another "The Smallest Animals We Have Seen." In addition to listing the names of animals, the children might draw pictures of them beside their names, or collect pictures of the various animals to place opposite the names on the chart.

Page 8 · Animals Large and Small

The questions on pages 6 and 8 focus attention on the illustrations.

The animals in the pictures again exhibit variety. They are both land and water animals. They are representative of several large groups in the animal kingdom. At the top of the page from left to right are a guppy, land snail, and shrimp. At the bottom of the page are a garden spider, bee, and housefly.

In discussing this page with children, the following questions also may be helpful: Have you ever seen any of these animals? Where? Do you know how large any of these animals really are? Are any of these animals on your list? How are these animals different from each other? Which ones could be seen better with a magnifying glass?

Pages 9–14 · Learning About Large Animals

On pages 9, 13, and 14, the animals are shown in their habitats. It is likely that very few children have seen a whale. The illustration on page 9 will help to make clearer not only what a whale looks like but also the way it moves about.

The illustrations on pages 10 and 11 serve to make more concrete the differences in size among animals. The child in the classroom may imagine himself in the place of the child in the picture and thereby gain some feeling of the great size of both the whale and the elephant. A further understanding of the proportions of a whale may be gained from the illustration at the bottom of page 11.

The animals shown on pages 13 and 14 are all large animals, but they are large in different ways. The giraffe is tall, and both the bison and the elk are massive. These animals live in different localities and have different surroundings. They all eat plants, but their adaptations for securing them are varied.

A giraffe has bodily adaptations, long legs and a long neck, for securing food from the high branches of trees. The markings of the giraffe provide an effective camouflage when it stands motionless among the patches of sunlight and shadow beneath the trees.

Bison are grazing animals of the open grasslands and prairies of the Midwestern United States. Their size is shown in their great mass and weight. They are large in a way different from that of a giraffe or whale. Unlike the tall giraffe, the stockily built bison is adapted for securing its food from the ground and low bushes of its prairie home.

Elk are mainly woodland animals. They, too, are considered large animals. But here again they are large in a way different from an elephant, whale, or giraffe. While elk usually have a fairly heavy body, their legs are slender and strong. Unlike any of the other large animals

mentioned on these pages, the elk has a set of large branching antlers which make it seem even larger than it really is. Each year these antlers are shed and a new set is grown. The horns of the bison, on the other hand, are similar to a cow's horns, which grow a little each year in length and circumference and once grown are not shed. Sometimes a bison may break or lose a horn in an accidental way. If this happens, the rest of its life is spent with only one horn. An elk may also break or damage an antler in an accident, but in his case a new and undamaged one replaces the old one when the next year's antlers are grown.

Pages 15–19 · Learning About Small Animals

Several of the animals discussed on these pages have a very wide geographic distribution and may be seen near the homes of children in many parts of the country.

The children obviously felt repaid for being quiet when they saw a bluebird in the tree.

Madison Public Schools, Madison, Wisconsin

If possible, go outdoors and observe some of these small animals in their natural habitats. It is likely that ants, earthworms, and hummingbirds may be seen right on the school grounds in many locations. Watch these small animals to see how they move about; the kinds of food they eat; where they make their homes; what sorts of body coverings they have; what the animals are doing at the time they are observed; and in what ways these small animals are different from each other.

Mud turtles and prairie dogs live in more specialized habitats and may not be as easily observed by most children as some of the other small animals mentioned. You may wish to make available to your class more information about these two animals through pictures or books obtained from the school library or a public library.

As children learn more about the animals in the story and on their charts their interests will very likely extend beyond the classroom and school out into the community. Going outdoors to see animals in their natural surroundings serves to clarify and make more vivid the experiences which children have within the school. The thrill of actually watching a robin fly to a bush nearby, or seeing a field mouse go scurrying through the grass in a meadow, or watching a squirrel scamper up a tree are experiences that cannot be duplicated inside the classroom. When observing animals, especially in their natural habitats, it is necessary to be very quiet. It is important that children see the reason for being quiet on such a field trip. If there is noise, most animals will have hidden or moved away before the children have an opportunity to see them. On the other hand, a quiet approach is usually rewarded by a close look at the robin, squirrel, toad, or field mouse that is the object of the trip. Once children have experienced the reward of a quiet approach they are usually very co-operative.

Pages 20–27 · Animals Have Many Shapes

The praying mantis, garden slug, dragonfly, and caterpillar are animals with strange shapes that can be seen in most areas of the country during warm days. One or more of them might be discovered in a short walk around the schoolyard. The children will want to study the pictures in *Science Everywhere* carefully before starting out. As they search for the animals see if the children realize how the shapes of the animals help to protect them from detection. After this firsthand experience of trying to find animals with shapes similar to objects in their habitat, see if the children can think of ways in which the shapes of other animals pictured in *Science Everywhere* help them to escape detection, to obtain food, or to protect them from enemies.

Page 28 · Animals All

Here are some of the animals the children in your class have been reading about in this chapter of *Science Everywhere*. As they read this summary page and discuss the material and illustrations questions such as the following may be used to guide the discussion:

Which of these animals was over 100 feet long?

How is a giraffe's shape helpful to it in getting food?

Which animal is so small that one must use a magnifying glass in order to see it clearly?

Which of these animals live in the water?

Which one lives in the ground?

Which one uses its nose to help it get food?

Children may also wish to make a chart or bulletin-board display of "Animals with Queer Shapes." For this, they may either take pictures from magazines and mount them on chart paper, or draw the pictures of queer-shaped animals.

Materials and Equipment

Materials needed for experiences suggested by *Science Everywhere*:

- books and magazines giving information about animals mentioned in Chapter I
- crayons or cold-water paints
- drawing paper
- pictures of animals not mentioned in Chapter I
- ruler, 1-foot
- tape measure or string 100 feet long
- yardstick

Materials needed for Additional Experiences and Activities:

- modeling clay
- newspapers
- wheat flour (for papier-mâché paste)

Additional Experiences and Activities

1. Visit a farm, park, or sanctuary to see the animals.
2. Have a pet show at school for a short time.
3. Make a booklet of "Animals with Strange Shapes."
4. Model animals from clay or papier-mâché.
5. Write stories and poems about pets.
6. Have a quiz program about the animals described in this chapter as a summarizing activity. Much information about the variety among animals given in Chapter I may be drawn upon for the quiz.

Children have been reading about and discussing animals as they have worked with this chapter of *Science Everywhere*. They may now wish to observe some of these animals at firsthand. The first two activities listed indicate two ways in which children may have this firsthand experience. As they carry out these activities concerning animals they may wish to recall some of the things they learned from this chapter. Such questions as the following might serve to guide their observations:

Which of these are large animals? Which ones are small?

Do these animals look different in ways other than size?

What different types of mouths, feet, noses, and body coverings can you note?

Did you read about any of these animals in *Science Everywhere*?
How do these animals move about?
Are they land animals or water animals?
Do these animals differ in the foods they eat?
How many different ways do they get their food?

In making a booklet about "Animals with Strange Shapes," children may refer to the illustrations in *Science Everywhere* in order to make accurate pictures. The illustrations in the textbook also will be helpful as a reference when the children model animals from clay or papier-mâché.

Evaluation

Do your children consider the differences among animals as laughable or "funny"? Or do they begin to accept differences as normal and expected among living things? Do they begin to understand that animals have certain adaptations which suit them to their surroundings; for example, the long legs and neck of the giraffe; the flat disklike shape of the sand dollar; the long, slim appearance of a walking stick? Are the children becoming interested in the great variety of living things around them rather than in just identifying the animals they see? Are the children developing a willingness to observe animals in the outdoors as much as possible, rather than a desire to collect them and bring them into the classroom? Are your children willing to check their opinions by observing again, experimenting, or doing further reading?

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Films

ANIMALS OF THE FARM. (CMP) color & b/w. The animals of the farm are shown in their true habitat.
BIRDS OF NORTH AMERICA, No. 5. (Heidenkamp) color, silent. The great horned owl and barn owl are pictured in action. (This is one of thirty-two reels depicting American birds.)
BLACK BEAR TWINS. (EBF) (Revised Edition) b/w. A family of campers observe a pair of small, hungry bears.
COMMON ANIMALS OF THE WOODS. (EBF) b/w. A study of various common animals in their natural habitats.
THE CURIOUS COATI. (YAF) b/w. The story of a small Central and South American animal related to the raccoon.
INSECT ZOO. (EBF) color. Reveals characteristics of insects in general and shows the distinguishing features of each insect portrayed.
LET'S LOOK AT ANIMALS. (YAF) b/w. An all-animation film which introduces the child to different animal characteristics.
MAMMALS ARE INTERESTING. (EBF) color. The distinguishing characteristics of mammals are illustrated in the many views of animals.
TINY WATER ANIMALS. (EBF) b/w. Time-lapse photography reveals the division of the amoeba. Cinemicrography discloses also the characteristics of common microscopic pond animals.
ZOO. (EBF) color. A visit to one of the world's largest, most modern zoos, where many different animals are observed in areas simulating their natural habitats.

Filmstrips

ANIMAL LIFE. (CurrF) 9 strips, color. *Mammals of North America; Looking for Animals; Fish; Reptiles; Snakes; Birds; Cats; Rabbits; Cows.*
ANIMALS AROUND THE WORLD. (PSP) color.
ANIMALS OF THE ZOO. (SVE) color.
AUDUBON'S BIRDS OF AMERICA. (EBF) 6 strips, color. *John James Audubon; Birds of the Countryside; Birds of Forest and Woodland; Birds of Towns and Villages; Birds of the Gardens; Birds of Sea and Shore.*
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BIRDS OF THE ZOO. (Curr) color.
COMMON ANIMALS OF THE WOODS. (EBF) color & b/w.
ELEPHANTS. (EBF) color & b/w.
FARM ANIMALS AND PETS. (SVE) color.
THE HORSE. (EBF) color & b/w.
LOW TIDE AT THE BEACH. (CurrF) color.
THE TURTLES. (CurrF) color.

II

How Animals Get Food

The obtaining of food is an important component of the self-preservation instinct of animals. Man usually depends upon three meals a day, but many animals spend most of their waking hours in search of food. There is great variety in the ways animals get food and in the amount of food they eat.

The second chapter of *Science Everywhere* discusses several animals with which eight- and nine-year-olds are usually familiar. The animals selected live in a variety of habitats, and each has some special body structure or habit which is an adaptation for obtaining food. Several different groups of animals are represented in this chapter. From the bird group, the swallow, owl, surface-feeding duck, and pelican are discussed; representing mammals are the coyote and elephant; and the butterfly is described as an example of the way in which one insect obtains food.

Science Meanings to Be Developed

Getting enough to eat is a real experience with youngsters. They seem always to be hungry. At recess time they may eat cookies or apples. At noon they eat a lunch brought from home or the lunch served in the school cafeteria. Then many children have fruit or milk and cookies when they arrive home from school. No wonder children sometimes hear their parents comment on the seemingly insatiable appetites of growing children with such remarks as "John must be a bottomless pit. He eats and eats, but never seems to be full," or "I just don't know where Susan puts all the food she eats."

For most children in America, a schedule of three good meals a day is so common that they take the presence of sufficient and nourishing food as a matter of course. Feeding their pets is also something frequently taken for granted, since the food for their pets is provided as regularly as for their own meals.

In rural situations, feeding the stock is part of the daily chores. On many farms there are chickens, ducks, or turkeys to be fed. In the barns, cows are fed as they are milked and horses are given grain and hay. On ranches in the wintertime, it is the rancher's task to transport food to stock out on the range, particularly when their natural food is

covered by ice and snow. Newspaper accounts of the operation of a hay lift during a blizzard in the Midwest serve to illustrate the lengths to which man must sometimes go to provide food for his domesticated animals.

Not all animals, however, can depend upon man to supply them with food. There is no one to provide food for the many, many wild animals found in all parts of the earth. These animals must depend upon their instincts in locating food, and upon certain body structures for securing the different types of foods upon which they live.

In the chapter "How Animals Get Food" children are introduced to the idea that there are differences in the ways animals get their food, as well as differences in their sizes and shapes, some of which were described in the preceding chapter.

The science learnings to be developed in this chapter are:

Animals need food. Animals get their food in different ways.

Some animals fly after their food. Some animals run after their food. Some animals swim after their food.

Many animals use parts of their bodies other than their mouths to help them get their food. Not all animals eat the same kind of food. Animals get their food in different places: in the air, on the ground, in the water.

Information for the Teacher

Birds, in general, must eat almost constantly to live. This is particularly true of young birds. Young robins, for example, eat from one half to their full weight in food each day.

Predatory animals are those which prey on other animals for food. Foxes, wolves, and coyotes are such animals. They are almost constantly on the prowl in search of food.

At certain times in their life histories butterflies, grasshoppers, aphids, and many other insects do little else but eat and reproduce.

Other animals can go for long periods of time without eating. Some snakes, such as the constrictors, eat animals larger than themselves and digest them very slowly. A python can swallow an animal as large as a young calf. Garter snakes sometimes swallow toads and frogs. These are such large meals that they last for a long time and enable these snakes to go for days without eating again.

Plants are a source of food for all animals, large and small, terrestrial and aquatic. Without plants, all animals, including man, would soon perish. Some animals feed directly upon plants. Grazing animals, such as cattle, sheep, and horses, eat grasses and soft-stemmed plants.

Browsing animals, such as deer, eat the leaves and bark of trees in addition to other herbage. Field mice and many birds feed upon the seeds of plants. Animals that eat plants directly are called *herbivorous* animals.

There are animals that depend indirectly upon plants for food. These animals usually eat the flesh of other animals that have eaten plants. Dogs, cats, lions, wolves, and birds of prey are examples of meat eaters, or *carnivorous animals.*

In addition to these two groups, there is a third classification of animals according to their food habits. In this group are animals that eat plants directly and also the flesh of other animals. Man belongs to this group, as do pigs, bears, and skunks. These animals are *omnivorous* and, as the name implies, eat many types of food.

Animals have many adaptations which enable them to survive in their struggle for an adequate food supply. Many of their bodily structures and living habits are positive adaptations for procuring and maintaining a food supply. The mouth parts of many animals are adapted to special ways of getting food. The beaks of birds are examples of such special structures. Some beaks, like the woodpecker's, are chisel-shaped for cutting through wood; some, like the finch's, are short, stout, and strong for cracking open seeds; some, like the brown creeper's, are long and slim for probing into cracks and crevices; some, such as the beaks of the heron, egret, and crane, are spearlike for impaling fish; and some beaks, like those of ducks, are flat and strainerlike for use as a sieve.

Small incisors and large canine teeth characterize flesh-eating animals. Such teeth are useful in holding and tearing meat. Man also has these incisors and four canine teeth, although the latter are not so well developed in human beings as in carnivorous animals. Most rodents and gnawing animals have well-developed incisor teeth that are usually quite long and chisel-shaped.

An animal usually depends upon more than just its mouth parts to help it secure food. Legs, feet, necks, and wings are accessory structures which also assist an animal to get food. The powerful legs and consequent swiftness of foot aid foxes, coyotes, and wolves to obtain their food as much as do their jaws and sharp teeth. The wings of butterflies, mosquitoes, houseflies, swallows, and bats transport these animals to their sources of food. The feet of other animals are as important in securing food as their mouth parts. Eagles, hawks, and owls, for example, have strong, stout toes equipped with long, curved talons. As they swoop down on their prey these talons enable them to hold on to their food and to carry it off to be eaten. Wading birds, such as herons and cranes, make use of their long, thin legs in getting their food. Because

their legs resemble the stems of reeds and grasses growing in the water, they are practically unnoticed by their prey. When small fish and frogs swimming near these legs are seen from above, they are caught in the spearlike beaks of the wading birds.

Many animals have survival adaptations other than their body structures which aid them in getting food. Some animals, such as ants, honeybees, squirrels, pocket gophers, and muskrats, store food to tide them over periods of short supply or times when conditions make it impossible to venture out in search of food.

Some animals respond to a scarcity in their food supply by migrating to regions where it is more abundant. Deer and elk, for example, follow their food supply. They feed in the higher altitudes during the summer months. In the fall, they gather in herds and move down the mountain slopes where the temperature is more moderate and the forage more abundant. African elephants and Rocky Mountain sheep also migrate in order to obtain food. When the supply in one region is exhausted, or there is food which they prefer in another region, they move to the more desirable feeding places.

There are food migrations among the insects also. The story of the tremendous hosts of crickets which swept over the grain fields of the Mormons in Utah is well known. Grasshoppers migrate in search of food. So do aphids. Some of these insect migrations are much shorter than those of larger animals. The whole migration may be confined to moving only from one field to a neighboring one.

Aphids respond in an interesting way to a scarcity in their food. They hatch from eggs in the spring as wingless creatures. They reproduce very rapidly until there are enormous numbers of them. When the numbers are so great that the food becomes scarce, a winged generation is produced. These winged aphids then fly away to another location where food is more abundant and there they start a new colony.

Hibernation is another response among animals which helps them to survive during periods of unfavorable weather and a scarce food supply. In the weeks immediately preceding hibernation, many animals eat until they have a heavy layer of fat on their bodies. This fat provides them with energy until the hibernation period is over and they can once again find food.

Among the mammals which hibernate are woodchucks, some bears, and some bats. These animals seek out secluded and protected spots in which to spend the time until food is plentiful again. Some bears hibernate in caves. Woodchucks remain in their burrows. Bats remain inactive in hollow trees or caves or old buildings until warmer weather brings with it a return of the insects upon which they feed.

Toads, frogs, box turtles, and snakes are among the cold-blooded animals which hibernate in response to changes in temperature and a scarcity of food. These animals must eat enough during periods of abundant food to carry them over these times of inactivity, since none of them eat while hibernating. Toads and frogs burrow into the mud along the banks of streams well below the frost line. Turtles hibernate in the mud at the bottoms of ponds or streams. Some snakes hibernate in rock fissures, hollow logs, or burrows, usually in a dry place. They seem to prefer sandy hillsides or rocky places on a south slope.

Some insects hibernate, also. A few houseflies crawl into cracks between boards or in the plaster of houses or into other protected places where they stay until spring. Mourning-cloak butterflies are one of the few insects which survive the winter in the adult stage. This butterfly hibernates in hollow trees, logs, or stumps and comes out with the first warm days of spring. Many other insects spend the winter period, a time of insufficient food, in the egg, larval, or pupal stage. This is true of most butterflies, moths, locusts, and aphids.

Ways of Working with Children

Children ask many questions in attempting to clarify ideas for themselves. It is part of the teacher's responsibility to help them find the answers to their queries. A teacher is not expected to be a walking encyclopedia, responding glibly to children's questions. Rather, her role is to encourage children to seek answers to their questions through their own efforts. She may reply in answer to a question, "How do you think we can find out?" or "Where should we look for an answer to B——'s question?"

In one instance, an excursion might provide the facts required. An experiment might help to solve another problem. In many instances, however, the necessary information is contained in books. *Science Everywhere* is one such book in which the content has been accurately compiled and written in language that children can comprehend.

The illustrations in *Science Everywhere* are as important as the text in conveying science meanings to the children. They are an outgrowth and an extension of the text in different form. They serve to tell the story and present the information through a pictorial approach.

Pages 31–36 · Many Ways to Get Food

Discussions are frequently an outgrowth of the illustrations in a textbook. The following questions are some that you may find useful in developing the science meanings in this section:

How do these deer get their food?

Where do they find their food?

How are their bodies suited to getting the kind of food they need?

What other animals do you think might get food in the same places these deer do?

How does this swallow get its food?

Where does it find its food?

How is a swallow suited to getting its food?

Can you think of other animals which get their food as they fly?

Can you tell what a swallow eats?

How does a wolf get its food?

What helps a wolf to get its food?

Where does it find its food?

Can you think of other animals which get their food in the same way that a wolf does?

Do you think a deer and a wolf could eat the same kind of food? Tell why.

How does an owl get its food?

How is this way of getting food different from that of the other animals you have seen in this story?

Why can you not eat the way a duck does?

Where do these ducks get their food?

What other animals get their food in the water?

What part of an elephant is its trunk?

How does an elephant use its trunk in getting food?

What kind of food does an elephant eat?

What other animals in this story eat the same kind of food?

Where does a pelican look for food?

What parts of a pelican's body help it in getting food?

What do you think a pelican eats?

How does a butterfly get to the place where its food is located?

What does a butterfly eat?

Which parts of a butterfly's body help it in getting food?

How is a butterfly's tongue different from yours?

Page 37 · How Do These Animals Get Food?

Page 37 is a summary and a review page combined. The animals shown on this page get their food in several of the different ways described in the second chapter of *Science Everywhere*. The individual animals, however, are not the same species which are discussed in the textbook.

The hawk (top row, left) gets its food in the same way as the owl

shown on page 34. The bat (top row, right) catches its food as it flies through the air, in a way much like the barn swallow on page 32. The coyote (bottom row, right) has its counterpart in the wolf on page 33. The squirrel, crab, and heron do not have counterparts described in this chapter, but rather are included to show additional ways in which animals get their food.

You will want to discuss this page with your children. Have them point out the means each animal uses to secure food. Let them note the specialized body structures each has to aid it in getting food, for example, the sharp teeth of the coyote, the wings and talons of the hawk, the long legs and spearlike beak of the heron, the pincers of the crab, the wings, erratic flight, and wide mouth of the bat, and the strong, sharp teeth of the squirrel.

Several charts may develop as an outgrowth of reading this page. One might be called "How Animals Use Their Feet to Get Food." On this chart children may list all the animals they know which use their feet in getting food. They may wish to draw pictures of each of these animals to go on the chart. They would doubtless include the hawk, owl, monkey, kangaroo, eagle, and squirrel.

Another chart might be titled "How Animals Use Their Noses and Beaks to Get Food." The heron, pelican, duck, and elephant could be among those pictured.

"Animal Mouths" might be the subject of another chart. On this chart children might draw the different kinds of animal mouths they have read about in this chapter, and beside each mouth the kind of food each animal eats.

As the children discuss and offer hypotheses about the animals shown on page 37 have them check their ideas by reading the other sections of the chapter which will help them to clarify their thinking.

Materials and Equipment

Materials needed for experiences suggested by *Science Everywhere*:

- cold-water paints
- crayons
- drawing paper
- pictures of animals mentioned in Chapter II

Materials needed for Additional Experiences and Activities:

- aquariums or terrariums with suitable habitat arrangements for animals brought into classroom
- chart paper for murals or friezes
- cold-water paints
- crayons
- food for animals

Additional Experiences and Activities

Additional activities which may be carried on during a study of "How Animals Get Food" are given below. As in all

the other suggested activities throughout *Science Everywhere*, the materials used are simple, everyday articles available in the children's immediate environment.

1. Observe animals in their habitats. Take a walk around the school grounds to see different animals and notice the ways they get food. Even in urban locales some animals are present, including squirrels, English sparrows, pigeons, dogs, cats, ants, spiders, and bees. The information gained about their feeding habits through an activity like this may be developed into charts, such as the following, and thus be available for future reference.

What Animals Eat Schoolyard Animals	What Animals Eat Farm Animals	What Animals Eat Our Pets
Sparrow	Cow	Dog
Honeybee	Horse	Cat
Butterfly	Sheep	Goldfish
Spider	Goat	Parakeet
Pigeon	Chicken	Hamster
Squirrel	Duck	Turtle

2. Keep animals in the classroom. In order to learn more about the food habits of one or two animals, it is sometimes desirable to bring animals into the classroom. However, before animals are brought to school several things should be determined: (*a*) Will the animal come from home, a pet shop, the outdoors? If the animal is to be taken from its natural outdoor habitat, it is well to consider with the children whether or not the environment can afford to lose the animal, even temporarily. A further consideration should be whether or not the animal can survive if removed from its natural habitat. In the interest of conservation, these two considerations are very important. (*b*) Can a comfortable environment be provided for an animal in the classroom? (*c*) What will the animal need while it is in the classroom? (*d*) How will it be cared for? Can committees share this responsibility? (*e*) How long will it remain in the classroom?

In the interests of health and sanitation, it is usually unwise to keep animals in the classroom for long periods of time. Some animals have received poor treatment at the hands of children, often because the children did not understand the natural requirements of the animals. Lack of proper attention and care often causes unpleasant odors in the classroom, and the accumulation of uneaten food and animal waste constitutes a health hazard. In some school systems (usually as a result of some of these unhealthful situations having developed) there are laws prohibiting animals in the classroom. Before you make plans for animals at school, it might be well to check with the principal to determine whether or not rules concerning such projects exist in your school system.

Some school systems have solved the problem of animals at school by providing wire enclosures for them on the school grounds. In these enclosures larger animals, such as sheep, calves, and colts, have been kept. This plan protects not only the health of the children but also that of the animals, since it keeps the children from handling or petting the animals too much.

Books proved a valuable resource when children needed to learn how to provide a home and food for an orphaned raccoon.

Allen Creek School, Rochester, New York

There are wild animals which seem not to suffer from periods of captivity provided the classroom environment is made as similar as possible to their natural habitats. Box turtles are among these. Box turtles are often found by youngsters in their yards or gardens and brought to school. This animal can be made comfortable in a large wooden box with

soil, grass, and leaves in the bottom, and a pan of water. Box turtles eat fish, houseflies, mosquitoes, berries, snails, earthworms, and chopped meat. Sometimes a box turtle will not eat in captivity. They can exist without food for some time.

Frogs, toads, praying mantes, salamanders, garter snakes, and caterpillars are among the wild animals which require little care and may be kept in captivity without apparent ill effects to the animals.

A well-constructed wire cage makes a satisfactory temporary home for hamsters in the classroom.

Madison Public Schools, Madison, Wisconsin

Pets and domesticated animals which may be brought into the classroom for "visits" include rabbits, white mice and rats, parakeets, goldfish and other tropical fish, guinea pigs, and hamsters.

One way that a teacher and children may learn how to provide a suitable environment for an animal is to look closely at the area where it was found. Unless it has been transplanted, the animal will be in a region to which it is more or less well adapted. Therefore, his temporary home in the classroom should duplicate the conditions in this habitat as closely as possible.

3. Use community resources. In learning about the food habits of different animals, the children may wish to find out more about what constitutes good food for growing boys and girls. In any study of nutrition, milk is among the foods considered. The local branch of the dairy

council will probably have materials and personnel available to schools. They usually have colored charts of many good foods, charts on the story of milk, ice cream, and butter, and films concerning nutrition. Through this or a similar agency the children may learn of the meticulous care which goes into the preparation of some foods.

The dietitian in the school cafeteria is a resource person available to teachers and children. She might be asked to visit the classroom and explain how foods are chosen for the cafeteria and some of the aspects of planning menus to provide balanced meals for children.

The parents or acquaintances of some of the children might be employed in food processing businesses, such as a cannery, bakery, or dairy. These people are usually willing to come into the classroom to discuss their specialties.

4. Develop dramatic play activities. Children enjoy impersonating people and animals. As one activity in learning how animals get food, children might portray different animals seeking food. One child at a time might give an impersonation of an animal feeding, and the remainder of the class as the audience might try to guess which animal the actor is imitating.

A group of children might portray a family doing their grocery shopping for a nutritious dinner or picnic. You will want to suggest that the "actors" consult health books or other authorities before making up their list of groceries so that they will know how to "buy" a well-balanced meal.

5. Draw and paint. Children may record some of the information they have learned about animals and their food habits by making a large mural or frieze. The mural might show different animals in their habitats as they seek food. The many food-getting adaptations of animals, as well as the differences in sources and kinds of foods, may be graphically shown in such a mural.

Evaluation

Evaluation constantly goes on in the classroom as you and the children together make decisions in the light of questions and problems that arise. Some of the questions you might keep in mind as you attempt to evaluate the progress of your group are:

1. Is the child growing in his ability to work as a co-operative and contributing member of a group?

2. Does he show evidence of being able to recognize problems?

3. In the class discussions does he contribute suggestions for the solution of problems? Does he show originality and resourcefulness in his proposed solutions?

4. Is he willing to change an opinion about an animal in the light of new facts and information?

5. Is he willing to withhold judgments until there is time to consider them and obtain information about them?

6. Is he growing in democratic thinking and behavior?

7. Is he developing a sense of responsibility for caring for pets or other animals entrusted to him?

8. Is he changing the way in which he discusses animals? Has his point of view about animals changed?

9. Is he beginning to gain some idea of the relationship between structure and food?

10. Do the spontaneous ideas he expresses show that he has gained understanding of animals and the ways in which they secure food?

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Films

AUTUMN ON THE FARM. (EBF) color. Two children are shown observing the fall harvesting of food and the preparations of animals for hibernation and migration.

CARE OF PETS. (EBF) b/w. Shows how a canary, goldfish, cat, and dog are cared for as household pets.

GARDENING. (EBF) b/w. Follows a boy and a girl through a gardening project from selection of seeds to examination of soils, control of pests, and use of vegetables grown.

HOW ANIMALS EAT. (YA) b/w. Explains the special food-getting adaptations animals have which help them to survive.

POND LIFE. (EBF) b/w. Depicts the pond as an organized community in which plants and animals are dependent on each other for life.

SEASHORE LIFE. (EBF) color. Shows three different kinds of seashores—the sandy beach, the rock pool, and the mud flat—and the animals that are found on each.

III

How Animals Escape from Enemies

In the chapter "How Animals Are Different" the variations in the sizes and shapes of animals are emphasized. The chapter "How Animals Get Food" shows the variety of ways in which animals secure their food. The third chapter of *Science Everywhere* points to another aspect of the variety among living things, namely, the many ways in which animals escape from their enemies.

Children often have opportunities to observe variations among animals. Undoubtedly they have watched a pet cat escape from a dog by scampering up a tree, or have seen a turtle escape from a curious dog by withdrawing into its shell. They may have had the experience of nearly stepping on a toad or a frog they did not see because of its resemblance to its surroundings. A few may have seen porcupines. Those who have may be able to describe the quills it uses to protect itself against enemies.

A variety of animals were chosen as examples in this chapter in order to give each child an opportunity to read about animals with which he may have had firsthand experience. If Tom has been stung by a bee, for example, he will certainly have experiences to relate concerning the way a bee escapes from its enemies. Mary may have found a box turtle in the garden that closed itself up in a hard shell when she started to pick it up. She will be able to relate the description of the turtle's escape from the dog on page 42 to her own experience. As a result, this information will have added meaning for her.

Science Meanings to Be Developed

The animals described in this chapter were chosen from many habitats and environments. Some are land animals, some are amphibians, and others live in the water. Some are found in the woods, some in the fields, and others may be seen in the yard or garden. Some may be found on a farm or ranch. Some may be seen at the beach. No matter where the children live, it is probable that they can find some of these animals in their environment. If children have seen the animals described in the text, the book will have more meaning for them.

It is the purpose of this chapter to develop the following science meanings:

Animals have certain adaptations which aid in their survival.

These adaptations may be specialized structures on their bodies or behavior habits.

Each kind of animal has its own special adaptations.

The adaptations of each animal are suited to that animal and are not necessarily good for any other animal.

These adaptations help an animal to be suited to its particular niche in the environment.

Information for the Teacher

Nearly all animals have some enemies. The ways in which animals protect themselves from these enemies are numerous. Some animals come together in flocks or herds and thus find protection in numerical strength. Others are nocturnal in habit and venture forth only when they find protection in the cover of darkness.

Some protective adaptations are passive ones; that is, they are adaptations which do not require much activity. Among these are camouflage or protective coloration, mimicry, and "playing dead." Other protective measures are more active ones. Many animals seek to escape from their enemies by running away or moving off quickly to places where their enemies cannot reach them.

Some animals are protected by their body coverings or by unpleasant odors or tastes. Still others fight their enemies with various weapons, such as claws, teeth, horns, hoofs, stings, and poisons.

Seven of the various means by which animals escape from their enemies are described below.

1. Camouflage · Many animals are able to escape from their enemies because their body colors are similar to the colors of their surroundings. This makes an animal difficult to see. Sometimes, in addition to their coloration, these camouflaged animals have markings on their bodies which serve further to conceal them from their enemies.

Toads are tan, gray, or brown. They are often difficult to see against the background of their habitat which is usually a garden or other place where soil is exposed. Their rough skin and their drab color help them to blend with the surrounding colors and textures of their habitat. Horned lizards are similar in color to toads. Their bodies are covered with rough horns or spines. This roughness, along with their gray or brown color, helps to conceal them as they make their way over the brownish-gray soil and rocks in their habitat. (See page 24, *Science Everywhere.*)

Many frogs live amidst green vegetation, usually near a pond, lake, river, or other body of water. Their colors are usually shades of green, which blend with the green vegetation where they live. (See page 41, *Science Everywhere.*) Another green animal is the praying mantis. This long, slim insect lives among the green leaves of plants. Since it is the same color as its background, the praying mantis is not easily seen by its enemies. (See page 20, *Science Everywhere.*)

Some garden spiders are so brightly colored that one might think their conspicuous colors would attract enemies rather than conceal the spiders from them. These spiders, however, live among varicolored blossoms, and in this setting they seem to be a part of the flowers. Because their bright colors repeat the colors of the flowers, it is often difficult to distinguish spider from blossom. (See page 41, *Science Everywhere.*)

There are many examples of camouflage among the warm-blooded animals. Certain birds, such as quail and grouse, have speckled, spotted, or barred plumage in black and white, and in shades of tan, russet, and brown. They live in weed patches, fields, and thickets. When these birds remain motionless among the spots of flickering sunlight and shadows in the grasses, they are practically invisible. (See page 40, *Science Everywhere.*)

The willow ptarmigan, a relative of the grouse, lives in the far north or above timberlines where there is snow on the ground most of the year. During the snowy months the ptarmigan's feathers are white. When seen against a snow-covered background, the bird escapes the notice of its enemies, the foxes and birds of prey. The ptarmigan's white plumage is replaced by speckled brown, buff, and black feathers during the summer months when the ground is bare. In the spring and fall, when there are alternate patches of bare ground and white snow, the ptarmigan wears still a different set of feathers. At these times the summer plumage is interspersed with a sprinkling of white feathers. These seasonal changes in feathers, occurring as the background colors of its habitat change, are a distinct benefit to the ptarmigan in escaping from its enemies.

The arctic fox, snowshoe rabbit, and weasel are other animals whose colors change with the changing seasons. Like the ptarmigan, these animals are white in winter, brownish-gray in summer, and mottled gray, brown, and white in the spring and fall. (See page 45 in *Science Everywhere* for a picture of a weasel in winter fur.)

Polar bears, which live in regions of perpetual snow, are white the year round. This white-on-white color scheme protects the polar bear from its enemies, among them human beings who hunt bear for food.

2. Mimicry · Some animals resemble their habitats not only in color, but also in shape. The walking stick, for instance, looks very much like a twig in both color and shape and consequently is often overlooked by its enemies. (See page 20, *Science Everywhere.*) A remarkable case of mimicry is displayed by the dead-leaf butterfly. The upper surfaces of its wings are brightly colored and would not be of much value as a means of concealment. Butterflies, however, hold their wings together over their backs when at rest, and in this position only the under surfaces are visible. The underside of this butterfly's wings look like a dead leaf, hence its name. In addition, the general shape and outline of the wings are leaflike. The markings look very much like the midrib and lateral veins of a dead leaf. There is also a spot on each wing without scales. This makes a transparent section which closely resembles a hole eaten in a leaf by an insect. The position which this butterfly assumes when at rest adds to the illusion of a dead leaf. (See page 20, *Science Everywhere.*)

Certain caterpillars look like plant stems and twigs. They are about the same size and color as the twigs on which they move in search of food. The larvae of the geometrid moths are known as measuring worms or span worms. They seem able to defy gravity as they hang suspended by feet at one end of their bodies and assume a position which makes them look like a leafless twig.

The close resemblance of the viceroy butterfly to the monarch butterfly seems to aid the former in escaping from its enemies. The monarch is avoided by birds and other insect-eating animals because of its disagreeable taste. The viceroy frequently escapes being eaten because it looks so much like the ill-tasting monarch.

3. Playing Dead or Seeming to Be Injured · Some animals feign death or injury in order to escape from their enemies. Perhaps the best-known animal with this habit is the opossum. When danger threatens, the opossum lies prostrate on the ground with its tongue hanging out. It remains motionless even though its attacker may paw or prod it. But when the attacker loses interest in the "dead animal," the opossum quickly comes to life and hurries off into the bushes or up the nearest tree.

The hognose snake also plays dead when danger is near. It rolls over on its back and remains motionless. When picked up and turned right side up, it immediately rolls over on its back again, assuming its "dead" attitude once more. The hognose snake recovers from its "death" as soon as its attacker has withdrawn.

Birds such as killdeers and grouse flop and flutter about as though their wings were injured when danger threatens their nests. As a pursuer follows a seemingly injured bird it is led farther and farther away

from the nest. When the attacker has been lured a sufficient distance, the bird quickly "recovers" and flies away. (See Gerald S. Craig, *Science for the Elementary-School Teacher*, New Edition, pages 529–531, for other examples of animals that feign death or injury as a means of escaping from their enemies.)

4. Body Coverings · Shells, spines, quills, and horny skeletons are examples of body coverings that protect animals from their enemies. Turtles, terrapins, and tortoises are examples of animals that can draw themselves into their shells for protection. Snails not only go into their shells, but they close the "door" after them. Many snails have a hard

Carolina Biological Supply Company

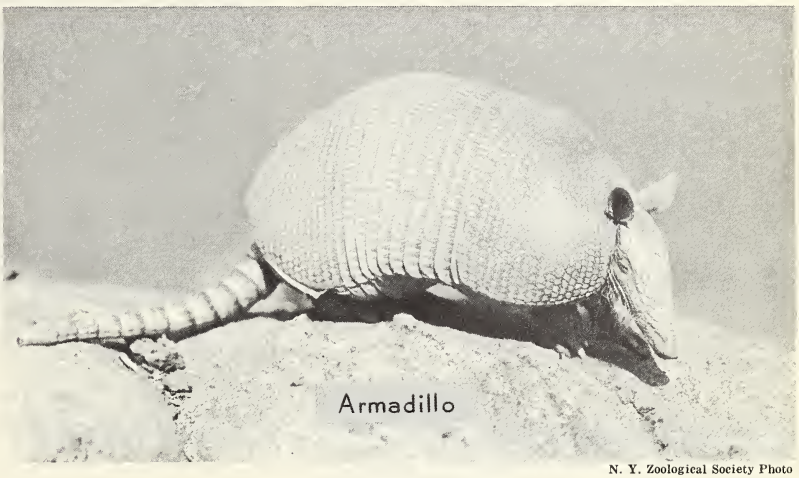
plate which covers the opening in their shells. When this hard plate is in place, the animal is completely enclosed. Among the many sea animals protected by shells are clams, oysters, cockles, scallops, mussels, abalones, ship worms, limpets, whelks, conchs, and barnacles. (See page 42, *Science Everywhere.*)

Sea urchins are protected by a covering of sharp spines that make them resemble a pincushion filled with pins. One species of sea urchin is shown in the illustration on this page.

Porcupines are protected by their quills. In addition to their hair covering, porcupines have quills which are long, stiff, sharp, and equipped with barbs. These quills are distributed over the back and tail of the animal. When a porcupine is attacked or alarmed, its quills are erected by means of muscles at their bases. An alarmed porcupine

raises its quills and swings its tail back and forth. If an enemy gets within reach of that tail, it usually receives some of the sharp quills. The quills are loosely attached to the porcupine and come out easily, with no injury to the animal which loses them. Contrary to a commonly held belief, a porcupine cannot "shoot" its quills into an enemy. The enemy must come into direct contact with the quills. Because of the barbs on each quill, it is a painful process to extract them once they are imbedded in the flesh. Porcupines are well equipped to defend themselves against most of their enemies. (See page 43, *Science Everywhere.*)

Animals with horny skeletons are found on land as well as in water. The armadillo is a mammal, but has little hair and very rudimentary teeth. Its body is covered with overlapping bony plates, and its long tail with overlapping bony rings. These bony coverings help to protect it from its enemies. The armadillo pictured here is found in Texas, southwestern Arkansas, eastern Oklahoma, and Louisiana.



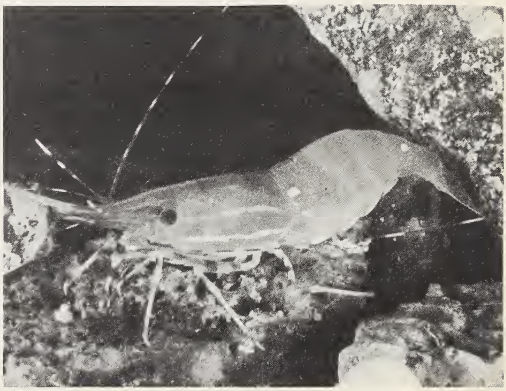
N. Y. Zoological Society Photo

Lobsters, shrimp, and crabs are among the sea animals protected by hard body coverings. These animals have their skeletons on the outside of their bodies rather than on the inside as do many animals. The pieces of these outside exoskeletons are made of chitin, a substance secreted by the animals. The skeleton is continuous, but it is thinner in some places than others so that the animal may move about. Such a body covering might be compared to a suit of armor. Crayfish are fresh-water animals which have exoskeletons. The illustrations on page 46 of this Manual show five commonly known animals that have exoskeletons. In addition, a shrimp is pictured on page 8 of *Science Everywhere.*

Crayfish

Blue crab

Lobster



Shrimp

Horseshoe crab

Note the various thin places in the exoskeletons that permit these animals to move about. Comparative sizes are not indicated. (Photographs by R. A. Boolootian, Hopkins Marine Station, and New York Zoological Park Photographic Department.)

Alligators, crocodiles, and rhinoceros also have tough body coverings, although they are not covered with chitin or shells. The skin of these animals is leathery and difficult for their enemies to penetrate. Their tough hide is a means of protection.

5. Flight · Many animals depend upon swift flight as a means of escaping from their enemies. (Flight as used here refers to any means of moving away quickly.) Deer, antelope, and rabbits, for example, escape by running away when danger threatens. Most birds fly to places where their enemies cannot reach them. Some water birds, which are clumsy and slow-moving on land, manage to flutter and flop into the water. Here they can swim away quickly and elude their pursuers. Or they may take to the air and fly beyond the reach of their enemies.

Fish and many other water animals are able to escape by swimming away from their enemies.

Worms and many insects escape by crawling away. Others, like the grasshoppers and fleas, use their powerful hind legs to jump out of danger. Some of the larger animals that also jump to escape from enemies are frogs, toads, some species of rats, including kangaroo rats, rabbits and hares, and kangaroos. (See the illustration, pages 38–39, *Science Everywhere.*)

6. Unpleasant Scents or Tastes · Skunks are perhaps the best known of the animals which produce obnoxious odors when aroused. Their defense is very effective in most cases. Some turtles also give off an unpleasant odor when they are disturbed. Garter snakes and toads produce a disagreeable scent when they are handled. It is thought by some that this is a means of defense for these animals. Among the insects which produce offensive odors the stink bug is probably the most familiar. It gives off an ill-smelling fluid when it is disturbed. Most birds leave this insect alone, since the fluid makes its body unpalatable.

The monarch butterfly is another insect which seems to be distasteful to its bird enemies. For this reason most birds leave it alone, too. Its unpleasant taste is an important survival factor for this animal.

7. Weapons · Many animals possess weapons which are useful defenses. The animals which use teeth and claws are far too numerous to list. Those most familiar to children of eight and nine probably are cats and dogs. Foxes, wolves, coyotes, bobcats, bears, and mountain lions also use these weapons. Rats, squirrels, weasels, woodchucks, mink, and wild boars depend upon their sharp teeth. Their feet are secondary defenses.

Horns and antlers are useful weapons, also. They are employed by many of the hoofed animals. Among these are cows, goats, buffalo, bison, deer, elk, caribou, moose, and rhinoceros.

Some animals paralyze their enemies with poisons. Bees, wasps, and

hornets, for example, inject poison into their enemies by means of stings. Rattlesnakes inject the poison through a wound made by their fangs, which are specialized teeth having hollow tubes. Poisonous spiders fight their enemies by biting them. The tarantula and black widow attack their enemies in this way.

Some sea animals, notably the Portuguese man-of-war, a species of jellyfish, and sea anemones, have many tentacles. Some of these tentacles are armed with minute batteries of poison darts. When an enemy attacks either of these animals and comes into contact with the stinging tentacles, the poison darts are released. The enemy is either killed by the poison which is shot into it or, if the enemy is large enough, it may be only slightly injured.

Ways of Working with Children

"How Animals Escape from Enemies" opens on pages 38–39 of *Science Everywhere* with a large illustration. The picture shows the ways in which several animals escape from their enemies. Encourage the children to talk about what is happening in the picture. You might ask: Which animals are afraid of the fox? How do they escape? Do all these animals escape in the same way? Do you think the fox will catch the woodchuck? Tell why.

Give the children ample time to express their ideas and opinions. In this way, you may gain an insight into their patterns of thinking. You may wish to discuss with the children what an "enemy" is. For example, how would the children answer such questions as: Why is a fox an enemy of a woodchuck? Why is a frog an enemy of a fly? It would be well to bring out here that animals are not enemies of each other because of any feeling of dislike or hatred between them. A fox does not dislike a rabbit. A frog does not hate a fly. No malice is involved. A fox chases a rabbit in order to get food. A frog flips out its sticky tongue at a fly for the same reason. These animals, as well as the hosts of others which inhabit the earth, are interdependent. Their interrelationship and consequent dependence one upon the other is one of the large meanings upon which elementary science is based.

Page 39 · Some Animals Go Away from Their Enemies

The survival adaptations of various animals are discussed in this chapter of *Science Everywhere*. On page 39 animals which escape by *moving off quickly* are emphasized. Have the children read this page to find examples of animals with this survival adaptation. You might ask when they have finished: Can you think of other animals which escape from their enemies by moving off quickly?

Pages 40–41 · Another Way to Escape

Escape by means of *camouflage* or *protective coloration* is discussed on pages 40–41. The animals described live in different types of habitats and belong to different groups of living things. As the children read these two pages they may think of other animals which escape from their enemies by means of their protective coloration. They may know of such animals in the immediate environment. Give the children an opportunity to talk about any of these animals they have seen or know about. If possible, take a walk to visit them in their natural surroundings. Discuss the questions asked in the text on page 41.

Page 42 · Some Animals Go into Shells

Animals also escape by *going into shells*. These animals do not need to move off quickly, nor do they depend upon camouflage to escape the notice of their enemies. Their hard coverings are adequate protection in most instances. By reading page 42 the children may learn about some of the animals with hard shells. Discuss with them other animals which can enclose themselves in shells. Perhaps one of the children can bring a box turtle or mud turtle to school for a short time. If so, allow the children to examine the structure of the shell. Notice that there is an upper and a lower shield to each shell. The shell is composed of plates with places for the head, legs, and tail to protrude through the shell. Across the bottom of the box-turtle shell the children can see a hinge-like division. Strong muscles draw this hinged "door" shut when an enemy approaches, thus enclosing the turtle in a "box." When danger seems to be past, the turtle again extends its feet, head, and tail beyond the protective covering of the shell.

If possible, bring various other types of shells into the classroom for children to examine. The shells of snails, clams, oysters, scallops, abalones, whelks, and limpets are usually available in the environment of children who live near salt water. Other snails may be seen in a home or school aquarium. Exhibits of shells may also be obtained in cases or sets from natural history museums or scientific supply houses. Addresses of several supply houses are given in the Appendix of this Manual.

Page 43 · Some Animals Have Quills

Another type of body covering which offers protection to its owner, namely, the *quills* of a porcupine, is described on page 43. Have the children read this page and look at the illustrations to find out: (*a*) where the quills are on a porcupine, (*b*) how a porcupine gets ready to use its quills, (*c*) what makes the quills stick in a porcupine's enemy, (*d*) in which picture they think the porcupine is preparing to use its quills.

Some children may have the erroneous idea that a porcupine can "throw" or "shoot" its quills. The teacher should take this opportunity to correct this misconception. Bring out the fact that the quills must actually come in contact with something before they come out of the porcupine.

Museum of Science, Boston

The model of a porcupine quill helps the children see how the sharp barbs make it cling to an enemy.

Page 44 · Some Animals Fight

Many animals are equipped with weapons. They *fight* against their enemies with these weapons instead of running away, escaping by camouflage, or going into a shell. Suggest that the children read page 44 to learn about some of the animals which fight to protect themselves. See if they can find in the illustrations ways in which the weapons are used. Some children in the class may have seen fights between cats, dogs, or horses. Encourage them to describe the ways these animals used their weapons to defend themselves and escape from their enemies.

Animals other than those described on page 44 which fight with their horns include cattle, sheep, mountain goats, and bison. Antlers are used as weapons, also. They are different from horns in that they are shed every season, whereas horns are retained for the life of the animal. Deer, elk, moose, reindeer, and caribou are among the animals which fight with antlers.

Page 45 · What Is the Best Way to Escape?

Have the children try to answer the questions on page 45 by looking at the pictures and remembering what they have read in the chapter. If differences of opinion as to facts arise, encourage the children to look back through this chapter from pages 38 to 45 in order to find information about the points of difference.

Materials and Equipment

Materials needed for experiences suggested by *Science Everywhere*:

pictures of animals showing defense structures, e.g., horns, hoofs, teeth, claws, shells, quills

Materials needed for Additional Experiences and Activities:

chart paper
magnifying glass
paints, crayons, or chalk
shells

Additional Experiences and Activities

1. Make a large chart, picture, or mural showing the many different ways that animals escape from enemies. Show an example or two of each type of defense mentioned in this chapter.

2. Look at the claws of a kitten and the teeth of a pet dog. Note how the kitten can extend its claws when ready to defend itself. Then notice how the claws are retracted when the kitten walks. Notice, also, the shape of the claws and how they are suited to scratching and tearing.

Look at the two long canine teeth in the upper and lower jaws of the dog. See how well their shape and size are suited to holding and tearing.

3. Take a walk to the woods, fields, a zoo, or natural history museum if one is near you. Try to find other animals that escape from their enemies by moving off quickly, camouflage, going inside hard shells, using quills or barbs, or fighting.

4. Examine the hard shells and coverings of animals, such as clams, turtles, and snails. Note how the hard covering of each completely encloses the animal. Notice the differences in the materials of which these coverings are made.

5. If some are available, examine the quills of a porcupine under a magnifying glass. Note how the end attached to the porcupine is relatively smooth. Then look at the other end and note the many barbs. These barbs make a porcupine quill stick firmly in any animal that gets close enough to the "porky" to receive one. The barbs also make the quills difficult to extract once they are embedded in an animal's flesh.

6. Have children bring to class a dead hornet, bumblebee, or wasp. (Ask the children to bring only insects they find that are already dead. Make it clear to children that they are not to go out and kill these

insects in order to obtain specimens.) With a magnifying glass, look at their stings. Note the shape and structure of these animal weapons.

Evaluation

A good way to determine the learnings children have acquired is to see how they use what they have learned. Do they talk about the various defense mechanisms of animals? Do they contribute to discussions in a manner which shows that they have thought about ways in which animals escape from enemies? Do they make worthwhile suggestions and carry them out? Have they grown in their concept of the great variety of defenses different animals possess?

A teacher will wish to be aware of the expression of children's ideas during discussions. Have they improved their ideas concerning animals? Are they able to utilize previous content in new learning situations? Have any of the children changed their attitudes or behavior toward animals in a postive and constructive way?

You may wish to evaluate a child's learning of science facts. There are many devices for checking factual learning. Two such devices follow:

1. Children usually enjoy quiz games. One may be arranged in which each child writes on a slip of paper a question to which he knows the answer. These strips are folded and put into the "quiz box." The children take turns drawing out questions, reading them aloud, and answering them, if they can. If they cannot answer, the question is thrown open to the class for answering.

You may check on concept formation by both the questions asked and the answers given.

2. If a written evaluation of factual learning is desired, a series of sentences such as the following may be used. The teacher may write the sentences on the board and ask the children to copy them, filling in the missing word in each.

a. Animals have many ways to (ESCAPE) from their enemies.
b. Many birds escape by (FLYING) into the air.
c. Sometimes a frog may escape by staying very (STILL).
d. A turtle, a snail, and a clam, each can close itself inside a (SHELL).

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BEACH AND SEA ANIMALS. (EBF) b/w. Structure, activities, and methods of protection of such animals as the starfish, sea urchin, lobster, and shrimp are shown.

CAMOUFLAGE IN NATURE THROUGH FORM AND COLOR MATCHING. (Cor) color. Shows how thirty-two species of birds and fish are protected by their disguised appearance.

HOW ANIMALS DEFEND THEMSELVES. (YAF) b/w. Shows the ways in which animals are adapted for protection against other animals and nature.

HOW ANIMALS MOVE. (YAF) b/w. Shows the ways in which animals are adapted for moving about in order to survive.

HOW NATURE PROTECTS ANIMALS. (EBF). b/w. Pictures examples of animals which are protected through fleetness, mimicry, coloration, and hard covering.

Filmstrips

ANIMAL PROTECTION. (CurrF) 5 strips, color. *Body Covering; Protective Coloring; Using Protective Coloring; Protective Weapons; Protective Behavior.*

IV

Changes All About You

One of the basic patterns in science is *change*. This chapter of *Science Everywhere* deals with some of the changes which children are able to observe in their immediate environment. Changes are going on about us all the time. We are immediately aware of sudden temperature changes and sudden weather changes, but certain other changes, such as the day-to-day growth of a child, the eroding of a piece of rock, and the building of soil, may be so gradual as to be almost imperceptible.

Everything, both living and nonliving, is changing in some way all the time. Rocks are slowly being worn away. The acids in water are dissolving the rocks and minerals over which they flow. Gradually the high mountains are being worn down by wind, water, volcanic action, and ice. The earth is slowly being built up in other places as a result of the deposition of sediments. The weather changes from day-to-day and from season-to-season. Animals change as they develop from birth to maturity. Growing is a change. Animals change as they respond to changes in their environments by growing warmer coats in winter and changing the color of their body coverings as the color of their backgrounds change.

Some of the daily or "short-time" changes which children can observe are discussed in the fourth chapter of *Science Everywhere*.

Science Meanings to Be Developed

A child is usually aware of some changes taking place about him in the environment. He may note changes in the sky from dawn to sundown, or changes in the weather during a day or week. If he lives in a rural community, he may see the changes in the appearance of a cultivated field during a growing season. He may notice the changes in the animal population in a given locality as the seasons change. If one of his chores is burning trash, he may note the changes which take place as various substances burn. He may be aware of numerous other changes going on about him, such as the evaporation of rain from a sidewalk after a shower, the rusting of iron, freezing of water and melting of ice, decaying, dissolving, and growing.

As children read the chapter "Changes All About You" and take part in the activities suggested there it is hoped that they will develop an increasing awareness of the changes occurring in their environment. In this chapter of *Science Everywhere,* the following science meanings are emphasized:

There are many changes going on about us all the time.
Evaporation is a change. When water evaporates, it goes into the air.
Rusting is a change.
Many things with iron in them will rust when they get wet.
Freezing is a change. We can speed up this change by mechanical means.
Melting is a change. We can speed up this change by applying heat.
Burning with fire is a rapid change. When paper, coal, and wood are burned, ashes are left as a result of the change which has taken place.
Decaying is a change. Humus is formed as a result of the change which takes place in the decaying of leaves, twigs, insects, other small animals, and other similar matter. Humus is necessary for the good growth of plants.
Dissolving is a change. It usually is a rapid change. Some things dissolve in water. Some things dissolve in turpentine.
Growing is a change. It is a slow change for most people.
Animals grow and change. Different kinds of animals grow at different rates of speed.
Some animals grow much faster than people do.
Plants change as they grow.
Different kinds of plants grow at different speeds.

Some of the larger meanings developed throughout this chapter of *Science Everywhere* are:

Some changes take place rapidly; others take a long, long time.
Living things grow. They change as they grow.
Living things grow at different rates of speed.
The life span of an individual may vary within a species.
The length of life differs among organisms of different types.

Information for the Teacher

On pages 48–49 of *Science Everywhere* the change involved in *evaporation* is described. The evaporation of water from the birdbath took nearly a day. The evaporation of water from the chalkboard took only a few seconds. Both are observable changes with which most children are familiar.

On pages 50–51 the change which takes place in *rusting* is pointed out. This is another change which occurs fairly rapidly. Iron nails left in water or in a damp place will rust in a matter of hours. Water left in an iron container such as a skillet becomes reddish-brown as the container begins to rust.

Freezing and *melting* are described on pages 52 and 53. In this case, the freezing and melting are caused by mechanical means in order to speed up results. But the children may have seen freezing and thawing in the out-of-doors, also. Encourage them to tell about their experiences with this kind of change. Freezing in the out-of-doors is described again in the chapter "Using Water Wisely."

Another rapid change is *burning*. On page 54, the text and illustrations show the changes which take place when paper, wood, and coal are burned.

Decaying is a change which may not be as familiar to children as the changes discussed on pages 48–54. Most children, however, are acquainted with the spoiling of meat, the souring of milk, and the molding of bread. Although for health reasons the change involved in decaying is usually not allowed to progress very far in a home situation, it may be observed in the out-of-doors in many places, such as the compost pile, the garbage dump, and the worm bed. In *Science Everywhere* a boy and his father note the results of decay as they get humus for the garden from the woods. The many organisms which have decayed to produce humus are indicated in the text and illustrations on page 55.

Any child who has stirred sugar into a glass of lemonade and watched the sugar disappear is familiar with the change known as *dissolving*. Some things will dissolve in water, some in turpentine, and some in other substances, such as mineral spirits, nail-polish remover, cleaning fluids, and the like. For the purpose of keeping the information simple and within the realm of children's experiences, the authors have selected as examples of items which will dissolve in water: sugar, soap, salt, and powder paints; and as one mixture which will dissolve in turpentine, house paint. As discussed on page 56 of *Science Everywhere*, dissolving is another "short-time change."

A slower change, that of *growing*, is discussed on pages 57–61 of *Science Everywhere*. The growth of girls and boys is a much slower and less apparent change than dissolving, rusting, or burning. A child is often unaware that he is growing until on his birthday, for example, he compares his present height with last year's, or until he tries to put on last season's clothing. Sometimes parents keep a record of growth for their children in the form of baby books or photographs taken each year on a birthday. Schools also are interested in the growth of children. In most

places, physical examinations are given each year, at which time the height and weight of each child are recorded and compared with the height and weight record of the previous year. Children are usually proud of the inches they have grown and the additional pounds they have gained in a year's time. Growing is a comparatively slow change, but it is nevertheless a very real one.

Children are usually able to watch the growth of some animal. Many will have pet kittens or puppies which they have watched grow into adult animals in a relatively short time. While Jimmy, for example, changes comparatively little as he grows from eight to nine years old, the puppy he receives for his eighth birthday grows into a nearly full-grown dog. Or Mary, for instance, may find that the tadpoles she saw at a pond about a month ago now have grown legs, their tails have been absorbed, and their change into frogs has been almost completed. These animals have a much shorter growing period than people do. Thus, the many changes which take place from birth to adulthood in these animals can be observed many times during the lifetime of one person. On page 59 in *Science Everywhere* the growth changes of a dog, a cat, and a frog are shown in the illustrations and described in the text.

Most plants which are known to children of this age are garden plants. A large number of these plants are annuals or biennials and reach maturity in a relatively short time. In contrast to the quick-growing garden plants are trees and some cacti. The giant saguaro cacti, for example, live many times the life span of a person. The sequoias of the west coast of the United States have existed for over a thousand years. The growth of some, as determined by the tree rings, is estimated to have begun before the birth of Christ.

Familiar garden plants have been chosen to illustrate changes in the growth of plants on pages 60–61 in *Science Everywhere*. Corn, tomatoes, and beans represent vegetables, and zinnias, sunflowers, and violets represent flowers. Even among these fairly rapidly maturing plants, there is variation in life span. Children may observe many changes in these plants as they are shown growing from seeds, producing flowers, fruits, and the seeds that provide for a new generation.

On page 61 of *Science Everywhere* an experience is suggested through which children might note at firsthand the changes which take place as plants grow from seeds. Some of the plants they grow may not develop and some may die before they produce seeds. Even with these apparent failures, changes will take place that can be observed and discussed. Because of the application of too much water, some seeds may rot before they have a chance to sprout. In this case, the process of decay may be noted. Too much or too little light may cause changes in leaf coloring.

It is likely that many changes may be observed in the plants during this experience, even though all of the plants do not grow to maturity.

Ways of Working with Children

You may open a discussion about this chapter by reading the title "Changes All About You" aloud. Then ask: What does the title mean? What changes are going on all about you? What changes can you tell about which are happening right now? Encourage the children to tell some of the changes which they have seen occur in their environment. Are they "short-time changes" which take place in a second, a few minutes, an hour, or a day? Or are they "long-time changes" which take weeks, months, or years to occur?

Page 47 · Many Real Changes

Several changes are pictured in the large illustration at the beginning of the chapter on pages 46–47. Have the children refer to the picture as you ask: What changes are going on in the picture? Which are short-time changes? Which are long-time changes? Have you ever seen any of the changes shown in this picture really happening?

The changes which are illustrated are: (*a*) the sky changing as sunset turns to twilight; (*b*) burning of wood; (*c*) cooking of frankfurters; (*d*) water becoming vapor and steam as it boils; (*e*) leaves becoming varicolored and falling with the coming of autumn.

As the children read page 47 begin to develop with them the idea that change is one of the large patterns of the universe. Help them to see that changes are going on constantly all about them. The text on page 47 tells of changes which are probably familiar to most eight- and nine-year-old children. Through the questions asked on this page the children are encouraged to think about and discuss other changes with which they are familiar.

Pages 48–49 · Evaporating Is a Change

Changes take place among living things and among nonliving things. On page 48 a change involving water, a nonliving thing, is described. Evaporation is a change which takes place when water goes into the air. This is what happened to the water in the birdbath in Fred's yard. Perhaps someone in the class has had an experience similar to the one Fred had in this story that they may wish to tell about.

Water evaporates from living things, too. For example, it evaporates from the leaves and stems of plants. It evaporates from our skin. This we notice most after we have perspired.

On page 49 Mary's experience with evaporation of water from the blackboard is described. This is essentially the same phenomenon as the evaporation of water from Fred's birdbath. The only differences are in the amounts of water, the length of time, and the size of the surface areas involved. At this point the children may wish to try the experiment that Mary did.

Page 50 · Rusting Is a Change — Page 51 · What Will Rust?

It is likely that many of the children will have had firsthand experiences with rusting similar to that of the boy with his skates described on page 50. The children very likely will want to tell of their experiences with this change. Give them an opportunity to do so. Then they may enjoy doing the experiment given on page 51. Using the information given on page 50 about things which will rust, the children may wish to make guesses about which items suggested in the experiment will rust and which will not. Guesses are the first step in the formation of hypotheses. Intelligent guessing based on information previously obtained is part of the process of concept formation and should be encouraged.

One of the most familiar things in a child's surroundings is water. In this section of the chapter water is shown in its three forms: as a gas, when it evaporated from the birdbath and blackboard; as a solid, when it froze in the refrigerator; and as a liquid, when heat melted the ice. The change which occurs when water goes from one state to another does not chemically change the water. Water is still composed of hydrogen and oxygen whether it is in the form of water vapor, ice, or a liquid.

Pages 52–53 · Freezing and Melting Are Changes

Some of the properties of ice indicated in the first paragraph on page 52 are "cold," "hard," and "made a clinkety sound." As the children read this paragraph ask them to pick out the words which tell what the ice was like.

We can sometimes speed up a change. That is what Patsy is doing when she puts water in the ice tray and returns it to the freezing compartment of the refrigerator. If the weather were cold enough, Patsy might make ice by placing the ice tray full of water outdoors. Patsy recognizes the fact that she merely speeds up a change by putting water into the refrigerator when she says, "Soon we shall have more ice cubes."

On page 53, Patsy describes another change which she can speed up. She says, "I can make the ice change. I can make it change into water again." Here again she only hastens the melting of the ice by putting the cubes on the stove. Make certain that the children understand that Patsy does not actually change the water in the sense that it becomes

another substance. The water changes only into another form when it freezes and melts.

It is advisable to relate these changes of freezing and melting to something in the child's own experience. At this point such questions might be discussed as: Where else other than the refrigerator can we speed up freezing? Where can we speed up melting? Quick-freezing in a deep-freeze and the mechanical freezing of ice for indoor skating are two instances where freezing is speeded up. Defrosting the car windshield, defrosting the refrigerator, and boiling frozen foods are illustrations of speeding up melting.

Page 54 · Burning Is a Change

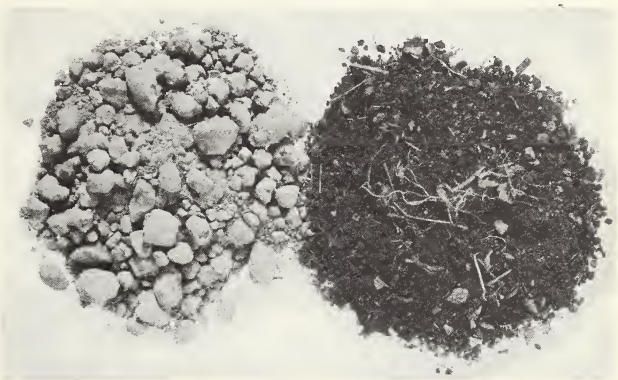
Burning is a change which children have seen. Burning with fire is a rapid change. On page 54 the three different things changed by burning are paper, wood, and coal. They are shown in the illustrations both during and after burning. In each case, ashes resulted. Give the children an opportunity to answer the questions on this page and to observe the ways the paper, wood, and coal changed as they were burned. Refer to the wood on the campfire shown on page 46. Ask which ashes shown on page 54 the campfire wood will resemble. Ask several children to bring to school newspaper, pieces of wood, and several lumps of coal. As the children examine these items you might ask: How do they look? How do they feel? How do they smell? Which are heavy? Which are light? If possible, provide paper ashes, wood ashes, and coal ashes and cinders so that the children can compare these items with the corresponding unburned objects. Suggest that the children note the changes in appearance, odor, texture, and weight. Point out that it was easy to hold the paper, wood, and coal in their hands before each was burned. Ask if it is as easy to hold the paper ashes, the wood ashes, or the coal ashes. The burned items tend to fall apart, sift through the fingers, or blow away. They are all much lighter weight as ashes. Burning is a dramatic change: It is a rapid change. It is a real change.

Page 55 · Decaying Is a Change

On page 55 the word *humus* is introduced. It is probably an unfamiliar word to many of the children. It should be written on the board and pronounced by the teacher before the children begin to read this page. As this new science word is introduced they will probably ask the same question that Andy asks, "What is humus?" They can find the answer to that question by reading page 55.

Humus is organic matter in the soil. It is made from decaying plant and animal substances. Leaves, twigs, bark, blossoms, and seeds which

fall from the trees each autumn accumulate on the ground underneath. Rain and snow wet this accumulation of plant material and make a suitable environment for the growth of bacteria. The bacteria attack the wet leaves and twigs and begin to break them down. They begin to decay. They fall apart and crumble into smaller and smaller pieces. Small animals, too, such as mice, shrews, earthworms, insects, and the like, die among this plant material each year. As their bodies are attacked by bacteria and begin to decay they are added to the crumbling leaves. The decomposed plant and animal material makes soil that is very fertile. This process of decay takes a long, long time. The formation of fertile soil is a slow change.



The soil at the left is deficient in organic matter, as can be seen by the hard lumps and gray color. Bits of roots and the dark color indicate that the soil at the right is rich in organic matter.

If possible, have the children bring samples of different kinds of soil to school. They should get the soils from different places in their surroundings, for example, sand from the sand box, and soil from the garden, a clay bank, the roadside, a shallow stream, and the woods. About a tablespoon of each type of soil is all that is needed. These samples should be taken with care, so as not to disturb any growing plants. Have the children look at these various soil samples with a hand lens or magnifying glass. Ask them: Do all the soils look alike? How are they different from each other? Can you tell what is in each kind of soil? Can you find humus in any of them? Humus usually contains traces of plant and animal life, bits of partially decayed plant stems, leaf skeletons, twigs, sometimes bird feathers, and the remains of small insects. Humus is usually dark colored and somewhat lighter weight than sand or clay.

Page 56 · Dissolving Is a Change

Dissolving is another important change. Without the change which occurs when substances are dissolved in water, our bodies could not

function properly. We could not eat some of the foods we now enjoy. We could not use salt or sugar as well if they remained in their solid form and did not dissolve in water. We would probably not be as clean as we now are if the soap we use to wash with did not dissolve to make suds. Substances which dissolve in water are discussed on page 56. Ask the children to name other things which will dissolve in water. Suggest that they name some which will not dissolve in water but will dissolve in turpentine, such as oil-base house paint and artist's oils. Allow children to experiment with different substances. Have them try to dissolve salt, sugar, soap, baking soda, detergent powder, and powder paints in water. Suggest that they try to dissolve house paint in water. Then have them try to dissolve sand, garden soil, or plaster of Paris in both water and turpentine. The results of these experiments could be recorded on charts such as those following with samples of each item in a small vial or cellophane bag displayed with the name of the item listed.

These Things Dissolve in Water	These Things Dissolve in Turpentine	These Things Do Not Dissolve in Water or Turpentine
Salt	House paint	Sand
Baking soda	Artists' oil paint	Garden soil
Sugar		
Detergent powder		
Soap		
Powder paints		

Pages 57–58 · Growing Is a Change

Perhaps children are not aware of growing as a change, but it is. Growing, for most girls and boys, is a relatively slow change. It cannot be so easily observed as dissolving, freezing, or burning. After the children read page 57, they will probably want to tell about their own birthdays, and how they celebrated them. To guide the discussion, you might ask such questions as: How old were you on your last birthday? Do you look the same now as you did two years ago (or two birthdays ago)? How have you changed?

The discussion may be continued as the children read page 58. On this page, a change in size is given as one indication of growth. It is well to point out here that all people do not grow at the same rate, or in the same way. All eight-year-olds are not the same height or the same weight. They all do not have brown hair, or blue eyes, or light skin, or dark skin, or freckled noses. What an odd and uninteresting world it would be if everyone grew exactly like everyone else.

There are many differences in the ways children grow. These differences are normal. We expect people to be different. Some children will grow tall; some will remain short. Some will be plump; some will be slim. But all will grow and change as they grow.

Page 59 · Animals Grow and Change

Animals grow and change just as people do. All living things grow. Page 59 describes in illustrations and text the changes which take place as three different animals grow. Have the children compare the illustrations of the young animals with those of the adults and point out some of the changes which occurred as these animals grew up. The following questions may guide the discussion:

How did the puppy change?
In what ways did the kitten change?
How did the tadpole change?
Which animal changed the most as it grew?
Have you ever watched any of these animals as they grew up?

The time involved in growing up also is pointed out on page 59. The life spans of a dog, a cat, and a frog are compared to a person's life span. The length of lifetime varies with different kinds of animals. It also varies among the individuals of a given species.

Children at this age level have a limited concept of time. It is difficult for them to comprehend the passage of a long period of time. A day and a week have some meaning for them, but in many instances they are not quite sure about "a month ago." A year ago is a very, very long time in the past, with the remembrance of a birthday or the celebration of a holiday such as Christmas their only means of measuring it. Watching the growth of an animal over a period of weeks or months gives children a concrete way of marking the passage of time. They may watch the growth and consequent changes of a pet, and can speak of time in relation to the changes in its appearance and habits.

Pages 60–61 · Plants Change as They Grow

Time and change are again involved in the growth of plants. In the activity suggested on page 60, children will have an opportunty to ob-

serve some of the changes that occur as a bean seed grows into a bean plant. By keeping a record of its growth, some of the important changes will be emphasized. Another activity on page 61 deals with the growth and change exhibited by several plants. Many changes take place as seeds grow. Some changes will take place even when the plants fail to grow to maturity. The children may wish to keep a record of the information they gain from this experiment. One way to do this is to record on a chart the changes which occur.

Page 62 · Changes You Can See

A review of four of the changes discussed in this chapter is given on page 62 of *Science Everywhere*. *Rusting, evaporating, dissolving,* and *growing* are the four changes, discussed in that order. The children should be able to answer the questions about each change from the information they have gained in this chapter. It is well to have them prove the answers to these questions by looking back to the appropriate pages in the chapter.

Page 63 · Some Things to Try

The activities given on page 63 should help to implement further the concept of change. These activities can be carried on with simple and inexpensive materials.

Materials and Equipment

Materials needed for experiences suggested by *Science Everywhere*:

cooking fat
crayons
garden soil in containers for seed beds
house paint
marbles
nails
paper clips
pennies
plastic comb
salt
sand
seeds: bean, corn, tomato; sunflower, violet, zinnia
soap
sugar
tacks
tumblers, 6
turpentine
water

Materials needed for Additional Experiences and Activities:

containers for food samples, 6
containers with screen cover for cocoons or tadpoles, if observed in classroom
cotton, raw
food samples, 2 each of bread, milk, uncooked meat
humus
magnifying glass
seeds: grass, lettuce, radish

Additional Experiences and Activities

1. Speed up a change. In the early spring, bring a budding branch into the classroom. If possible, secure the branch from a tree or shrub which can be seen from the classroom window. Lilac, forsythia, or any of the flowering fruit trees can be used. Since many shrubs are pruned each year, the cutting of a small branch is not likely to injure the plant. Place the branch in water and put it in a sunny, warm part of the room. Watch for the changes which take place. Compare the cut branch with those still on the tree or bush outdoors to see which one has flowers first.

As a rule, the practice of bringing things from the environment into the classroom is not to be encouraged with children. In the interest of conservation, it is much better to take children outdoors to see the various changes which plants and animals undergo at different times of the year.

The activity suggested here deviates from the usual practice of studying living things in their natural environment. The reason for this deviation should be made clear to children. By removing the branch from its usual environment, certain changes may be produced which will take place only by changing the environment. In this case, the change involves bringing the branch indoors.

2. Slow down a change. In three small containers place separately a piece of bread, some milk, and a piece of uncooked meat. Keep these items in an out-of-the-way place in the room, such as on a shelf or in a cupboard. Place three other containers holding the same three types of food in a refrigerator. Note which milk sours first, which bread molds first, and which meat spoils first. Ask the children to keep a record showing how much longer the foods in the refrigerator were edible than those left outside. Be sure they understand that decaying is the change slowed down by refrigeration.

3. Observe changes from the classroom windows. Observing changes in the landscape is a year-round experience. Answers to the following questions might provide a "continued story" to be recorded by the children in a booklet called "Scenes Outside Our Windows":

How does a heavy rainstorm change the looks of the schoolyard?

How does a high wind change the way the schoolyard looks?

How does a heavy frost change the appearance of the landscape?

How does the appearance of the surrounding community change with the changing seasons?

4. Observe seeds sprout. Put several kinds of seeds on damp cotton. Watch the changes which occur. Suitable seeds for this experience are

radish, clover, grass, and lettuce. Since these seeds sprout fairly rapidly, the children begin to see changes almost at once.

5. Observe the development of insects. It is often interesting and educational to watch the changes made by insects as they progress through their life cycles. Whenever possible, it is suggested that children go outdoors and see animals in their natural surroundings.

Cocoons and egg cases are usually plentiful in the late summer. When these items of interest are located by children, encourage them to leave the insects as they find them. Then at intervals the class may take walks to see the changes which occur in the cocoon, chrysalis, or egg case.

If it is impossible to take the class to see an egg case or cocoon in the outdoors, these items may be purchased for classroom study. Scientific supply houses offer them at a small cost. Theirs are raised especially for distribution to schools, colleges, and other educational organizations. When cocoons or egg cases are obtained in this way, the environment is not disturbed and conservation practices are not violated.

If insect egg cases or cocoons are secured for study in the classroom, place them in a container with a wire-screen cover. Watch to see how they change. To guide their observations, ask the children to observe whether the young look like the adults, and how many different changes the insects make before they are grown and resemble their parents. When the insects are full-grown, be sure they are released in their natural environment.

6. Watch frog or toad eggs hatch. By far the best way to learn about changes in living things is to see them in their natural surroundings. Take a walk to a pond or stream to see frog or toad eggs. At a later date return to the pond to see what changes have taken place in the eggs. On successive visits it should be possible to see tadpoles in varying stages of development.

Living specimens of the tadpoles of frogs and toads may be secured for classroom study when it is impractical or for some reason undesirable to go outdoors to see them. Scientific supply companies usually have these in stock.

Tadpoles in the classroom should be kept in a container of pond water. The chlorinated drinking water of many localities is often noxious to living things not accustomed to it. Keep the water temperature as near that of their original habitat as possible.

Observe the changes which take place as the eggs become tadpoles and later frogs or toads. When the demonstration has been completed, release the animals in their natural environment.

7. Examine a handful of humus. Look at the humus under a magnifying glass. Ask the children to make a list of all the different things they can find which have gone into the making of humus.

Evaluation

It is not always possible to evaluate at once the learning which has taken place in a classroom. Sometimes a child does not express what he has learned until a long time after the learning experience has taken place. How are we to know then whether or not children have acquired the learnings we have tried to emphasize?

A clue to the amount of learning which has gone on lies in the changes in attitudes and behavior of children exposed to that learning. For example, are they more observant of the many changes which occur about them every day? Do they talk about these changes? Do they express a curiosity about why these changes happen? Are they eager to find out about other changes in their environment? What ideas do they contribute to discussions about changes in their environment?

How do they react when changes such as these actually take place: (*a*) a sudden, violent thunderstorm occurs; (*b*) the differences in heights and weights among children in the class are made apparent after physical examinations; (*c*) a child of another race enters the class; (*d*) a power failure results in the lights going out? Do they consider the scientific facts behind these changes and accept them as the results of definite things? Or do they resort to superstition and magic to explain these happenings?

Another way to evaluate the learning which has taken place is to prepare a summary in the form of a chart. Such a summary chart might be titled "Changes We Know About." Ask the children to put on this chart the new information they have acquired about change.

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Films

ANIMALS GROWING UP. (EBF) b/w. The growth of a litter of puppies, a newborn calf, and a hatching of chicks is traced during the first few weeks of their lives.

BABY ANIMALS. (YAF) b/w. Explains the degree and nature of parental care among animals, and the relationship between the number of young, amount of parental care, and chances of survival.

FIRE. (Gateway) b/w. Shows what is needed to make fire, what it does for us, how to control it, and how to prevent it.

FIRE PREVENTION IN THE HOME. (EBF) b/w. Uses a story to demonstrate important aspects of fire prevention in the home. Stresses making it a family matter in which children and parents co-operate.

MONARCH BUTTERFLY STORY. (EBF) color. Close-up photography shows the life cycle of the butterfly from laying eggs, through the caterpillar stage, and on to the emergence of the butterfly from the cocoon.

PLANT GROWTH. (EBF) b/w. Close-up and time-lapse photography picture the complete life-cycle of the pea plant. Animated drawings depict fertilization.

SUMMER ON THE FARM. AUTUMN ON THE FARM. WINTER ON THE FARM. SPRING ON THE FARM. (EBF) 1 reel each, color. Each film shows the changes that take place in plant and animal life during the respective seasons.

WHAT IS SOIL? (IF) b/w. Explains that soil is essential to all living things, which, in turn, contribute to its formation.

WHAT THE FROST DOES. (Cor) color & b/w. Shows signs of seasonal changes and the effects of frost.

Filmstrips

AUTUMN AND WINTER. (PSP) color.
SPRING AND SUMMER. (PSP) color.
THINGS IN THE WORLD CHANGE. (PSP) b/w.

V

Using Magnets

The topic of magnetism is one that lends itself well to learning through manipulation and experimentation. Playing with magnets is a popular pastime with children of elementary-school age. Even in the kindergarten and first grade, many children have had some experience with magnets. Children a little older often bring magnets to school. They may bring small horseshoe magnets which are parts of toy sets purchased at the ten-cent store, or large U magnets from old automobiles or telephones. Some may have magnetic toys which they enjoy showing to the children in the class.

As a result of playing with magnets at home and at school, children often discover some of the things a magnet can do. One of the first things they usually find out is that magnets will attract some things but not others. They are able to see by comparisons that magnets have different sizes and shapes.

When a child brings a magnet into the classroom, he likes to demonstrate some of the things he can do with it. Almost immediately other children want to "try out" the magnet, too. They may want to try things different from those which the other children have tried. Also many children enjoy doing the same activities over and over again. "Do it again"; "Let me try it"; "What else will it pick up?" are comments often heard when children are experimenting with magnets. It is artificial in most instances merely to talk about using magnets. Children are eager to hold the magnet in their own hands, to try its weight, to feel the pull, to try experiments for themselves. The chapter on "Using Magnets" in *Science Everywhere* is designed to give children many opportunities to experiment with magnets and to find out something about magnetism from firsthand experiences.

Science Meanings to Be Developed

The ideal time to begin a study of magnets is when a need for a magnet arises in the classroom. Such a situation might arise when pins are spilled and need to be picked up, or when nails must be collected quickly from the corners of a workbench drawer.

A roller-skate key may have been dropped through the iron grill over a window well. A nut or screw may have rolled beyond reach under a piece of heavy furniture. In any of these situations a magnet would prove useful in retrieving these articles.

Obviously you cannot always count on such situations as these to occur at the most appropriate time for the study of magnets. You may wish to begin the study of magnetism at a particular time to furnish background information for science study to follow or because an interest in magnetism has been aroused through a story the children have read, or because someone has brought a magnet to school, or to fulfill a course of study requirement, or for some other reason. However, the topic of magnetism is practically self-motivating. All a teacher needs to do to engender interest is to place several magnets on a table along with a variety of items with which to experiment, then stand by and watch the children's native curiosity begin to work.

This chapter of *Science Everywhere* develops science meanings about magnets and magnetism which the authors hope will be helpful to you in working with magnets in your own classroom. The following science meanings are emphasized in this chapter:

Magnets attract some objects but not others.

Magnets may vary in their shapes. The shape of a magnet does not alter the way it acts. Magnets attract objects containing iron or steel.

A magnet has two poles, a north pole and a south pole. The poles of a magnet are near the ends. The poles are the holding parts of a magnet.

Two unlike poles will attract each other. Two like poles will repel each other.

Some tools are magnetized to increase their usefulness.

Iron or steel objects which are not magnets can be magnetized by contact with a magnet.

A compass needle is a magnet that is free to move.

Information for the Teacher

A magnet is a piece of iron or steel which has been magnetized. Magnets have different shapes. The ones most frequently used are the bar magnet, horseshoe magnet, and U magnet. Although the shapes of magnets differ, they all act the same way. The shape of a magnet has nothing to do with the things it attracts, or the things one can do with it. These three types of magnets can be bought through scientific laboratories or scientific supply houses. (See pages 151–152.)

There are also natural magnets, or lodestones. These are made of an iron ore called magnetite. Lodestones are called natural magnets because

they are made by natural rather than artificial processes. It is thought that lodestones secure their magnetism from the earth. When these pieces of magnetite are hung so that they swing freely, they come to rest in a north-south direction. They attract things with iron and steel in them just as artificially made magnets do.

Another type of magnet is the electromagnet. Some children may have seen electromagnets in operation in small electric motors belonging to older members of their families. They may also have seen the electromagnets used in junk yards to lift large pieces of scrap metal. Electromagnets are widely used in industry. They are not, however, discussed in the chapter "Using Magnets."

Every magnet has a north pole and a south pole. These poles, which are the holding or attracting parts of a magnet, are at the ends. The pull of a magnet is stronger at the poles than in the middle. Every magnet, no matter what its shape or size, has two poles. There is no such thing as an isolated pole. If you were to break a bar magnet in half, the result would be two smaller magnets each with a north and a south pole. If you were to continue breaking the magnet into smaller and smaller pieces, the result would be smaller and smaller magnets, but each piece would still have a north and a south pole. On page 67 of *Science Everywhere* there is an experiment which demonstrates the polarity of magnets.

The opposite poles of a magnet attract each other, and like poles repel each other. In other words, a north pole will attract a south pole, and a south pole will attract a north pole. Two north poles or two south poles, however, will repel each other. An experiment to show this attraction and repulsion is given on pages 68–69 of *Science Everywhere.*

Sometimes tools are magnetized to increase their usefulness. Tack hammers are often magnetized so that they will hold tacks. Scissors are sometimes magnetized so that they may be used to locate and pick up pins. These two tools are illustrated on page 70 of *Science Everywhere* and described in the text on that page.

Magnets can be made in the classroom. They will be rather weak and their magnetism can be easily destroyed, but such magnets will serve to indicate how magnets can be made. On page 71 of the textbook an experiment is given describing the steps involved. You will probably wish to try this experiment yourself before having the children try it. You may use a steel knitting needle, steel darning needle, or sixteenpenny nail for this experiment. Draw the knitting needle across one pole of a magnet. The number of strokes across the magnet will vary. If the magnet being used is weak, more strokes will be necessary. If the magnet being used is strong, fewer strokes will be needed. After twenty strokes across the magnet, always in the same direction, test the needle

for magnetism. You may do this by trying to pick up steel pins, thumb tacks, or other metal objects. A soft-iron bar such as a nail can be magnetized fairly easily, but it will also lose its magnetism quickly. The denser steel knitting needle or darning needle will take longer to magnetize, but it will retain its magnetism for a longer time.

A compass needle is a magnet. It has a north pole and south pole. One end of the compass needle always points north in response to the earth's magnetism. On page 74 in *Science Everywhere* is an experiment describing the way to show that a compass needle is a magnet. Test the needle by bringing the south end of a magnet near the north-pointing end of the compass needle. The two unlike poles will attract each other. Next hold the north end of a magnet near the south-pointing end of the compass needle. These two unlike poles also will attract each other. Then try the reverse of these procedures. Hold the north end of a magnet near the north-pointing end of the compass needle. Watch the free-swinging compass needle whirl away from the magnet. Put the south pole of the magnet near the south-pointing end of the compass needle. Again the compass needle will move away from the magnet, thus showing the repulsion that occurs when two like poles are brought near each other.

Ways of Working with Children

"Using Magnets," as the name implies, is a doing unit, an activity unit. The children will actually use and handle magnets, in addition to reading and talking about them. The children talked about in the textbook are doing things with magnets. Activities which may be carried on in your classroom are directly stated or implied on nearly every page of this unit. The illustrations, in many instances, show how to carry on these activities, and the materials and equipment needed for them.

Page 65 · Experimenting with Magnets

The opening text and illustrations on pages 64–65 set the tone of the chapter. The activity described is one in which many children are trying out magnets of different sizes and shapes. Since the children in your classroom will wish to experiment with magnets, too, it will be wise to have several magnets available so that groups of children may work together. In this way, no one will have long to wait for his turn to use a magnet, and a high level of interest may be maintained.

Some of the many things which may be experimented with are illustrated, including pins, scissors, pencils, string, marbles, paper, and paper

clips. One method of obtaining an interesting variety of objects to use in this experiment is to pass a bag or box among the children in the class, and ask each child to contribute one item he wishes to try to pick up with a magnet. Each child may also like to guess whether or not a magnet will attract the object he has contributed. Ask the children to state the reasons for their guesses with such questions as: What makes you say that? Why do you think so? Have you ever seen anything happen like that?

As the children experiment in a free activity period the teacher may write these two headings on the board: "Things a Magnet Will Attract" and "Things a Magnet Will Not Attract." As the children determine which things are and are not attracted they may list them under the appropriate headings. These lists from the board may be transferred to charts for a more permanent record.

Page 66 · Magnets Have Different Shapes

On page 66 of *Science Everywhere,* the children are given the names of the three most commonly used magnets. They are asked to experiment with each type, to compare the way the three act, and to notice whether or not the shape of a magnet has anything to do with the way it acts. The children will find that the shape of a magnet does not affect the things a magnet will attract, that, in fact, both a horseshoe magnet and a U magnet are shape modifications of a bar magnet.

They will find by reading page 66 that the things a magnet attracts are made of iron or steel, or have iron or steel in them. As they refer to their list of "Things a Magnet Will Attract" they may be surprised to learn that some of those items contain iron or steel. Some of the girls may not have realized that their bobby pins were steel. Some children may have thought that magnets attract all pins and will be surprised to find that pins may appear on both lists. A magnet will attract steel pins, but it will not attract brass pins.

At this point, it might be well to check on the guesses that the children made as they began their experimenting. They will be interested in finding out if (*a*) anyone guessed correctly; (*b*) which guesses were incorrect; (*c*) what previously known information the correct guessers used; (*d*) what the incorrect guessers learned about the things a magnet will attract.

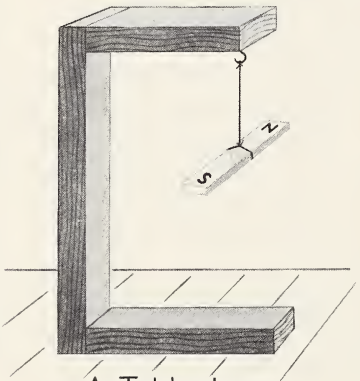
As the children try to pick up different things with their magnets they may notice that a magnet does not hold things all over it. They may have seen that the magnet attracted more pins, or other steel objects at the ends than it did in the middle. In the illustration on page 67, they may see a situation parallel to the one they have experienced in

the course of their experimentation, namely, that a magnet holds things at its ends.

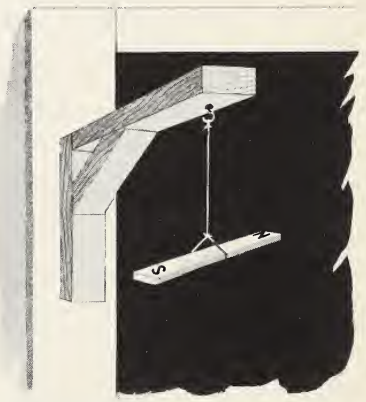
Pages 67–69 · A Magnet Has Two Poles

The children are encouraged in the textbook on page 67 to try an experiment, such as the one in the picture, to prove that the holding parts of a magnet are at the ends. It is here that the word "pole" is introduced. Some children will know about the north pole and the south pole on the earth. The idea of a north pole and south pole on a magnet may be entirely new to them.

Through the experiments suggested on page 68, the children will gain the information that even though both poles of a magnet attract neutral



A. Table top



B. Chalkboard moulding

objects of iron and steel, a magnet acts differently when brought into contact with another magnet. They may think that something is wrong with their magnet when they bring two north poles or two south poles together and there is no attraction. The magnets are made of steel, and the children may generalize that since magnets attract things made of iron and steel, they should attract each other, no matter what poles are brought near each other. Here the concept of repulsion is introduced as a part of the phenomena of magnetism.

Work with the children as they carry on the activities described on page 68. Listen to their questions and spontaneous explanations of the things that happen. Questions and unsolicited, on-the-spot explanations often give the teacher valuable clues to the patterns of thinking being used by the children.

The experiments suggested on page 69 further implement the idea of

attraction and repulsion introduced on the preceding page of *Science Everywhere.* In the line drawings on page 74, two ways to suspend magnets for this and similar experiments are shown.

Page 70 · Tools That Are Magnets

Two examples of tools that have been magnetized are given on page 70. If children can bring similar tools to school, have them do so. Scissors and tack hammers such as those described may be purchased at most hardware stores. Since the children will undoubtedly enjoy experimenting with magnets, they may have the idea that magnets are just toys. They will be interested in learning that magnets are also useful tools. Encourage them to think and talk about other places where they have seen magnets "at work." If any of them have used magnetized tools, they may wish to describe their experiences for the rest of the class.

Page 71 · Making a Magnet

Children may be surprised to learn that magnetism is not some remote force made by mysterious means, but a force they can see in action right in the classroom. Should a teacher ask, "Would you like to make a magnet?" he would probably be deluged with such comments as, "You mean we can really do that?" "Let's make one now." "How do you start?" "What'll we make into a magnet?" "Show us how." By reading page 71 and following the process step-by-step as explained in the illustration, the children should be able to make a magnet. The illustration shows both the steps in making a magnet and the materials needed. Encourage the children to try to magnetize several different things, for example, a steel knitting or darning needle and nails of different sizes. See which items make the strongest magnets by comparing the number of small steel pins each will attract. For the sake of experimentation and learning, try also to magnetize things which will not magnetize, for example, a wood dowel, a brass rod, or an aluminum spoon.

Pages 72–74 · A Compass Needle Is a Magnet

It would be well to have a compass in the classroom for the children to observe before reading page 72. Give the children an opportunity to see the compass and to talk about it, to note the letters on the face, to see that the needle moves, and to observe where it comes to rest. A discussion about the compass might follow as the children consider: What is a compass for? How is a compass used? What do the letters on the compass face stand for? Is this compass like one I have used? The text on page 72 will help to answer some of these questions. The illus-

trations show one use for a compass, and in the text opposite the bottom picture the letters on the compass face are explained.

Page 73 further explains the way a compass works. The earth acts like a big magnet, although the exact cause of the earth's magnetism is not known. It is as though there were a large magnet inside the earth. The attraction of the earth causes the needle on the compass to come to rest in a north-south direction. One end of the compass needle points north in response to the earth's attraction. The other end points south. Actually the compass does not point true north at all places on the earth. The variation of the needle from geographic north and south is different at different places on the earth. Also the presence of steel girders, iron pipes, or other objects having a strong magnetic attraction may cause the needle to deviate temporarily.

The north-pointing end of the needle does not always come to rest over the letter N. To find north, the compass must be turned until the north-pointing end of the needle is directly over the letter N. On most compasses the north-pointing end of the needle is indicated by an arrow-shaped point or by a color.

When the direction of north is known, it is a simple matter to find the other directions. Since one end of the compass needle points north, the other directions can be determined from this. If a person faces north, south is automatically behind him. Just as certainly, east is to his right and west to his left. The boy in the illustration at the bottom of page 73 is demonstrating this. With the classroom compass, locate north. Then have the children locate the other directions as the boy in the picture is doing.

Review with the children the concept of the attraction of unlike poles and the repulsion of like poles. Then ask if someone could demonstrate with a magnet that the compass needle also is a magnet with two poles. Use the children's reaction to such a question to note their certainty or uncertainty about the information already presented. The concept of attraction and repulsion is not an easy one. Children often get confused by the north pole repelling a north pole. They often think that because the poles are alike they should attract each other. Take time, if necessary, to go back and review the information on pages 68–69. Perhaps the children would benefit at this time from a reworking of the experiments given there. Then have the children read page 74. This page gives the information necessary for carrying out another experiment. Allow several children to try it. Let them see at firsthand the way the needle on the compass swings away when two like poles are brought near each other. Let them watch the needle swing toward the magnet when two unlike poles are brought together. If the compass needle were a

neutral piece of steel, both ends would be attracted by the magnet. Repulsion of the needle is the real test for polarity. If the needle has poles, it cannot be neutral and is therefore a magnet.

Page 75 · Two Experiments for You

Two other experiences with magnetism are given on page 75. The needle in the first experiment can be magnetized by following the directions on page 71 for magnetizing a needle. Nail polish makes a good quick-drying paint for use on the cork.

In the second experiment, the theory of borrowed or induced magnetism is illustrated. This theory is too complicated to present to children of eight or nine, and no attempt should be made to explain it to the class. Rather, the idea to emphasize is that some neutral objects can be made to act like magnets if they are held against a magnet.

Materials and Equipment

Materials needed for experiences suggested by *Science Everywhere*:

- bowl or shallow dish
- compass, inexpensive, e.g., Boy-Scout
- corks, several small
- magnets, in as great a variety and number as possible
- nails, 16-penny or 8-penny
- needles, steel, knitting and darning
- objects for experimentation, e.g., aluminum spoon, brass rod, marbles, paper, paper clips, pencils, pins (steel) or thumb tacks, scissors, string, wood dowel
- stand or support for free-swinging magnet

Materials needed for Additional Experiences and Activities:

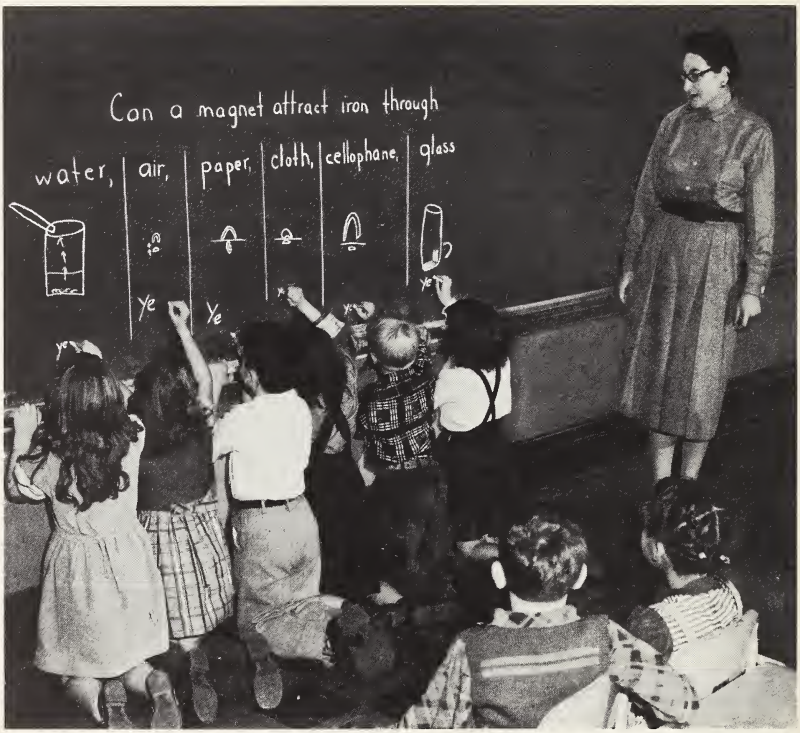
- aquarium or glass bowl
- cardboard or piece of glass, approximately 6″ × 8″
- iron filings in shaker
- iron pan or skillet
- lodestone
- magnets, 1 bar, and 1 smaller for "fishhook"
- paper, heavy drawing or construction
- paper clips
- string
- tacks, steel, small
- wood blocks, 2, size of larger magnets
- wood dowel rod

Additional Experiences and Activities

1. Find the poles on a natural magnet (lodestone). A natural magnet has poles just as does one made by artificial means. Try to obtain a lodestone and locate its poles. A lodestone may have more than one north and one south pole. Regardless of the number of poles, for every north pole there is a matching south pole. The poles may be determined by placing the lodestone in a dish of small steel tacks or iron filings. The metal objects will be attracted to the poles of the lodestone in little bunches. By bringing the lodestone near a compass, the north and south poles of the lodestone can be distinguished.

2. Demonstrate that magnetism passes through some substances and is absorbed by others. Place tacks on a wooden table top. Reach under the table with a magnet and move it along the underside of the table top. Watch the tacks move with the movements of the magnet. They are attracted through the wood of the table. Magnetism passes through wood unless the wood is too thick or the magnet too weak.

Try this experiment with the tacks on a piece of window glass. Move the magnet about on the underside of the glass. Again the tacks will be attracted by the magnet through the glass.



A picture test may assist children in summarizing their learning experiences with magnets.

Official Photo, Board of Education, New York

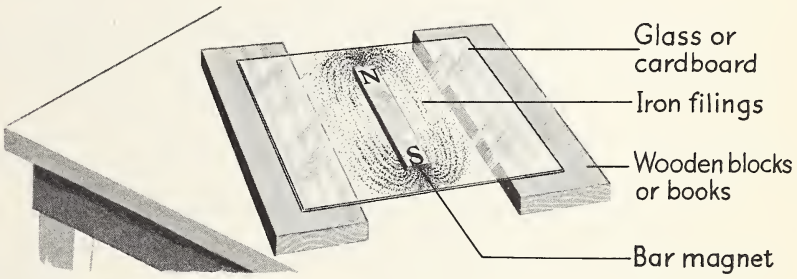
Experiment with the tacks on a piece of cardboard. The magnetic attraction will pass through the cardboard and attract the tacks.

Place the tacks on an iron skillet or iron pan. Move the magnet about on the bottom of the pan. Note how the pan attracts the magnet and makes it difficult to move. The iron pan will partially or entirely screen the region beyond it from magnetic attraction so that little or none will reach the tacks.

3. Show the area of attraction around a magnet. Around every magnet there is an area of attraction, or an area within which the influence of a magnet is felt. This is called a *magnetic field.* It is larger for powerful magnets and smaller for less powerful ones.

The children have *felt* the pull of a magnet as they were doing the experiments in this chapter. They have also experienced repulsion. Through the activity which follows, they will have an opportunity to *see* the field of influence which surrounds a magnet, in other words, its magnetic field.

Lay two pieces of wood about the same thickness as the magnet on a table. Place them four or five inches apart. In the space between the pieces of wood place a bar magnet. Then lay a piece of stiff cardboard



or glass over the wood and the magnet. Hold a shaker of iron filings above the table and sprinkle the filings over the cardboard or glass. The best results are obtained when the shaker is held about three feet above the cardboard and when fine iron filings are used.

Tap the edge of the cardboard gently with a pencil or your fingertips. As the cardboard is tapped the iron filings will arrange themselves in a definite pattern about the magnet. The filings will form lines from one pole of the magnet to the other. These lines are called "lines of force" and show the pattern of the magnetic field around the magnet. The children can see how each line begins at one end of the magnet and continues to a matching portion at the other end of the magnet.

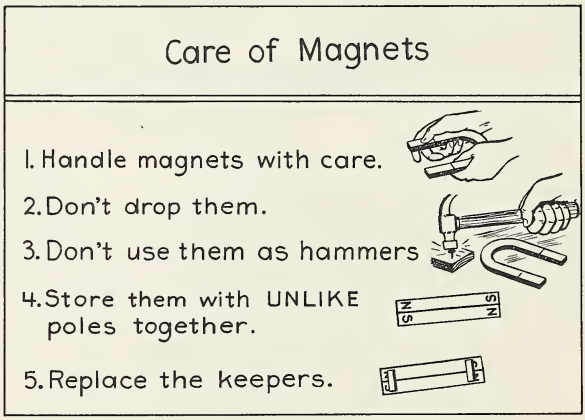
This activity may be tried with different kinds of magnets, and with different combinations of poles near each other. When two like poles are placed near each other, the lines of force form quite a different pattern than when unlike poles are near each other, as is illustrated in the diagram.

4. Make a magnetic fish pond. From Manila or colored construction paper, cut about a dozen small fish. Fasten a small paper clip to the

"nose" of each fish. Print a number on the side of each fish and place them in a glass dish or empty aquarium. Make a fishing pole from a length of $\frac{3}{8}$-inch dowel rod or other small stick. Tie one end of a 14- to 18-inch string to the end of the pole. To the other end of the string fasten a small magnet. Then let the children "catch" the fish in the aquarium with the magnetic "hook."

As each child catches a fish he records the number on its side as his score for that turn. When all the fish have been caught, the children add their scores by totaling the numbers on the fish they have caught. The winner is the one with the highest score. Then all fish can be returned to the pond and the game started again.

5. Illustrate the proper care of magnets. Children will be interested in learning that the length of time a magnet remains useful is greatly influenced by the kind of treatment it receives. If a magnet is frequently dropped or used as a hammer, or stored improperly with two like poles together, it will have a very short life. Magnetism may be destroyed by any of these misuses.



Drawings illustrating the following rules for the care of magnets might be displayed on a wall chart while the children are using magnets:

a. Avoid dropping a magnet or pounding with one. [Jarring tends to disarrange the molecules within the magnet and to change it into a neutral bar of steel.]

b. When magnets are put away, store them with *unlike* poles together. [This tends to keep the molecules in line and somewhat strengthens the magnet. If like poles are stored together, the constant repulsion tends to push the molecules out of line. This also destroys magnetism.]

c. It is a good idea to place a soft-iron bar across the ends of a magnet when it is stored. [This small bar, called a "keeper," is usually included with bar magnets when they are bought in pairs.]

Evaluation

Observing the behavior of children is one way to evaluate their learning. Watch to see what children do with magnets in a free activity period. For example, do they try new things with magnets, or do they tend to repeat the same experiences over and over? How do they care for magnets? Do they remove objects from the magnets at the end of an activity? Do they store magnets in the manner suggested?

As the children talk about their experiences with magnets:

1. Do they show any changes in their thinking about what a magnet can and cannot do?
2. Do they test ideas they have about magnetism by experimentation?
3. Do they tolerate differences of opinion?
4. Do they apply learnings of the past in trying to solve new problems?
5. Can they think through their explanations?
6. Are their explanations reasonable and logically expressed?
7. Are the ideas they express based on their science experiences?

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Films

MAGNETS. (Gateway) b/w. Shows how the magnet is used in doorbells, telephones, and commercial electromagnets.

MAGNETS. (YAF) b/w. Demonstrates the nature and behavior of magnets, based on the activities of two children who learn about a simple bar magnet.

Filmstrips

ELECTRIC MAGNETS. (SVE) b/w.

MAGNETS. (YAF) b/w.

VI

Using Electricity

Electricity is one of the great sources of energy in the world. It is a physical force which man has learned to use to improve his way of living. He uses electricity, for example, to illuminate his home and city, to cook and preserve his food, to clean his house, to improve his communication with distant places, to furnish him with entertainment. The amount of electricity man has harnessed for his own use is small compared with the vast amount of electrical energy available in the universe. The electrical energy in a single flash of lightning is greater than the electricity used to light a house for many days.

Magnetism and electricity are closely related. Both are physical forces and sources of energy which man has learned to use to some degree. Scientists do not, however, have the final answer as to what electricity and magnetism really are.

It is the purpose of the chapter on "Using Electricity" in *Science Everywhere* to present a few of the science meanings necessary for the understanding of certain simple electrical phenomena.

Science Meanings to Be Developed

The use of electricity is so much a part of the lives of most children today that they take it for granted. Many children have never been without electricity and the convenience it affords. Some may have experienced the inconvenience of being without electricity for brief periods during thunderstorms, on camping trips, or during a stay at a vacation cabin. But for the great majority of children, using electricity is as routine as eating three meals a day.

The science meanings developed in "Using Electricity" are for the purpose of helping children understand something of the way electricity works, how it travels, how it can be controlled, and how it is useful in everyday life. Although the situations suggested in this chapter involve working with a dry cell and a small light bulb, the electrical principles involved are the same as those used in wiring a full-sized house.

These science meanings are developed:

There is energy in a dry cell. This energy may be used to light a bulb.
Electricity needs a complete pathway in order to travel.

Wires, a dry cell, and a light bulb can make a complete pathway for electricity.

A break in an electric pathway, or circuit, stops the flow of electricity at that point.

The flow of electricity along a pathway, or circuit, may be controlled with a switch.

A switch is a safety device as well as a convenient means of controlling the flow of electricity in a circuit.

Information for the Teacher

Electricity is of two types—static electricity and current electricity. *Static electricity* is electricity which is at rest. It is evidenced by the snapping of one's hair when it is brushed or combed; the sparking of a cat's fur in the dark; the shock which one receives when touching a doorknob or chair after scuffing across a carpet; the way in which one's clothes cling to him in dry and often in cold weather. For a detailed explanation of static electricity, the teacher is referred to Gerald S. Craig's *Science for the Elementary-School Teacher*, New Edition, pages 738–747.

Current electricity is electricity in motion. It is this type of electricity with which this chapter deals. Current electricity must have a pathway along which to move. This electric pathway is called a *circuit*. Substances which make good pathways for current electricity are known as *conductors*. Some substances make poor pathways and may even impede the motion of current electricity to the point of stopping it altogether. These substances are nonconductors, or *insulators*. Man uses insulators to help him control the flow of electricity. Insulators keep electricity from going where it is not wanted.

Conductors are used to carry electricity along a certain pathway, or circuit. These conductors are usually in the form of wires. Silver is an excellent conductor, but the price of silver wire makes it prohibitive for commercial use. Another good conductor is copper. Copper wire is extensively used in everything electrical, from toasters to cross-country power lines. Aluminum and iron are other good conductors that are used in electrical circuits.

Some nonconductors, or insulators, in common use are glass, porcelain, paper, rubber, and sealing wax. Frequently conductors are covered with insulating material in order to keep the electricity from going where it is not wanted. Copper wires often have an insulating cover of rubber or wax-impregnated cloth on them. The insulators on many power poles are made of glass or porcelain. These nonconductors keep the electricity from traveling down the pole and into the ground or nearby objects,

where it might be dangerous to people and animals or might cause damage to property.

When working with electricity, it is important to keep it traveling along its intended circuit. Insulators make this possible. A lineman, for example, works with electricity powerful enough to kill him, but he is not harmed. The reason he can work safely with such tremendous electrical forces is that the conductors of electricity are *insulated.* Because the wires are insulated, the electricity stays within them and does not come into direct contact with the lineman. It is when insulators are removed and electricity travels outside its intended pathway that accidents occur. Electric shock and fires may then result.

Electricity is sometimes produced by chemical means. The electricity made in a dry cell is made in this way. Within a dry cell, the energy in the chemicals is changed into electrical energy as a dry cell is connected by wires to a light bulb, bell, or other electrical device. Dry cells are in common use in a number of places. For example, dry cells are found in some radios, in flashlights, and in flash attachments for cameras. They are used as a source of electrical energy for the horns and lights on bicycles. They supply the current needed for many electrical games.

The outside of a dry cell is a zinc cylinder or cup with a top of metal and sealing wax or tar. The zinc cup contains a black substance which is a mixture of ammonium chloride, manganese dioxide, zinc chloride, coke, and graphite. In fresh dry cells, this black material is in paste form. In old cells, it dries to a black powder. Between the black material and the zinc cup is a liner of heavy blotting paper which absorbs moisture and helps to keep the paste moist for a longer time.

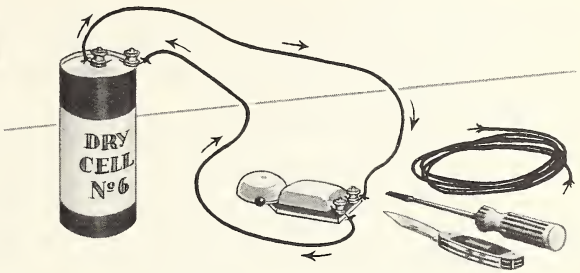
A carbon rod goes down through the center of a dry cell. At the top of this carbon rod is a screw for fastening a wire to the rod. Another screw for fastening a second wire is on the edge of the zinc cup. These two parts of a dry cell are called the binding posts. Wires are bound around these posts and under the screws when a dry cell is connected into a circuit. The post in the center, the carbon rod, is called the positive or plus (+) pole. The post on the edge of the zinc cup is called the negative or minus (−) pole. In order for a dry cell to function in a circuit, a wire must be attached to *each* of these binding posts, and then to the light bulb, doorbell, or other electrical device.

Electricity can travel along a circuit only if that circuit is complete. In other words, there must be a continuous pathway for the electricity from its source, which may be a dry cell, through a wire, through a bell or light bulb, and back through another wire to the dry cell again. This complete pathway for electricity is called a closed circuit.

Dry cells may be used in a classroom with safety. They contain no

harmful acids or other harmful materials. The amount of electricity produced by a dry cell is exceedingly small, so there is no danger of receiving electric shocks from using them.

As children experiment with a dry cell, wire, and a light or bell they will probably find it inconvenient to disconnect the wires from the binding posts every time they wish to turn off the light or stop the bell from



The complete circuit runs from the dry cell to the bell and back to the dry cell.

ringing. Another way to control the flow of electricity along a circuit is with a switch, which makes it possible to break a complete pathway, or closed circuit. When a circuit is broken and the pathway is no longer complete, the electricity stops at the break.

A switch provides a convenient way to obtain a break in an electrical circuit. We use switches numerous times every day, almost without thinking. We use switches to turn radios, television, vacuum cleaners, mixers, electric fans, sewing machines, electric ranges, and lights on and off.

Switches also provide a safe way to stop and start the flow of electricity. If there were no switches, electric circuits would have to be broken by pulling out plugs to appliances, unscrewing light bulbs, or cutting wires. Burns and electric shocks would be almost certain to result. The part of a switch which comes into contact with the hand is an insulator. Since electricity cannot travel through it, it is safe to touch and handle.

Ways of Working with Children

Frequently an activity period in which children manipulate materials and "try out" things effectively stimulates their thinking. This chapter provides opportunities for children to experiment with a dry cell. It would be well to make available for their experimentation several dry cells, an electric bell, several small sockets and low-wattage light bulbs, and a dozen or so 24-inch lengths of copper insulated bell wire. Throughout the activities connected with this chapter

encourage the children to try different circuits and see who can make the bell ring or the bulbs light.

Pages 77–78 · Experimenting with a Dry Cell

From the text on page 77, the children learn that Jack and Jerry are going to put a light in the dollhouse. Jack thinks that he knows how. You might ask if anyone thinks that he knows how to make the bulb light. Give volunteers an opportunity to make a circuit with the dry cell, wires, and light. They may attach the wires as Jack did, and be surprised that the bulb does not light, or someone may make the circuit complete on the first trial.

As they read farther on page 77 the children will find that electricity needs a complete pathway in order to travel. The idea of electricity traveling on a pathway may be new to many children. They cannot see electricity traveling anywhere. In fact, they may not know what sort of pathway electricity needs.

They may have traveled on many pathways—through the woods, along the beach, across a meadow, across a vacant lot. A pathway, in the sense just described, is probably well known and understood by children eight and nine years old. On a pathway a person goes from one place to another, often returning to the place from which he started. In order to make the idea of a pathway more graphic, you may wish to draw on the blackboard a simple map of the area near the school. Have several children describe their pathways to school and draw them each with a different colored chalk on the map. To aid them in giving pertinent information, you may ask: Where did you start? Where did your pathway end?

Very likely each child's pathway starts at home and ends at home, although he may have started out in one direction and gone home by a different route. The pathways drawn by the children resemble closed loops, beginning and ending at the same place. As each child travels his pathway he makes a complete circuit. If the jogs and turns in the pathways could be straightened out, the pathways would resemble a circle.

In order for a bulb to light, electricity must make a complete trip around its pathway, starting at the dry cell, going through the wire to the light, and back through another wire to the dry cell again. It must make a circle or circuit.

The children may ask, "How does the electricity get from the dry cell to the light?" "What does it use for a pathway?" The wires are the pathway for the electricity. But the electricity must make a complete trip around its circuit, or pathway, before the bulb will light.

Have the children look at the way Jack has connected the equipment

in the illustration and compare it with their own connections. To assist them in checking their circuits you might ask: Is the pathway complete? How will the electricity get from the bulb back to the dry cell again? What pathway will it use? Where should the wire go to complete the pathway? When someone discovers the need to add the second wire in the circuit, you might allow him to complete the circuit and make the bulb light.

After the children have tried to make the bulb light, have them turn to page 78. If they have been successful in making a complete pathway and the bulb lights, they may use page 78 to verify their circuit connections. If they have not been able to make the bulb light, they may use the information supplied on page 78 to help them connect the equipment correctly.

Pages 79–82 · Turn It Off — Turn It On

Now that the children know how to make the bulb light, they may wish to turn it off. On page 79 Jean asks, "How can I turn off the light?" Ask the children in your class this question. See whether any of the responses are similar to those given in the textbook, for example, unscrewing the light bulb, unfastening a wire from a binding post, or cutting a wire. Your children may suggest other ways.

See if the children without looking ahead to page 80 can guess how father will make the bulb light again. Try the suggestions, or guesses, with the equipment at hand. Then read the first two paragraphs on page 80. If your children have not tried touching the wires together to make the bulb light, have them do so. When the ends of the wires are touched together the bulb lights.

Cutting wires, however, is not a good way to stop the flow of electricity along a circuit. For one thing, it is inconvenient. When electricity is wanted again, the wires have to be held together. With any electrical source more powerful than dry cells, cutting wires is not only inconvenient, it is exceedingly dangerous. It is important that you explain the danger of shocks and burns if wires carrying a stronger current, such as that used to light houses, are cut. House current is sufficiently strong to kill a person. Cutting wires as a way to break a circuit is NOT TO BE TRIED EXCEPT WHEN THEY ARE ATTACHED TO DRY CELLS.

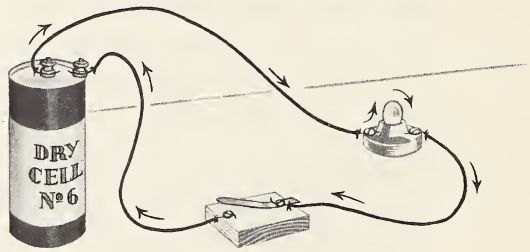
In the third paragraph on page 80, father also says that there is a better way to control the flow of electricity. He suggests the use of a *switch*. This is a new science word and time might well be taken here to discuss what a switch is, and what a switch can do.

In the illustration at the bottom of page 80 of *Science Everywhere*, the parts of a simple switch are shown: a small block of wood, a strip from

a tin can, and two screws. The text and illustrations on page 81 give step-by-step the information needed to make this switch. The screws will go into the wooden block more easily if a hole is made in the block with a nail first. After the switch is assembled, the children may put it in their circuit. As the textbook states, this small, homemade switch works the same way as the light switches in a house. The way to add a switch to a circuit is illustrated here.

Of course, just inserting a switch in a circuit will not make the bulb light. The switch must be closed to make a complete circuit before the bulb will light. (See the illustration at the bottom of page 82 in *Science Everywhere.*)

Some children may be surprised that the bulb still does not light after the switch has been inserted. This is a good time to review pages 77–78,



dealing with an electric pathway. The idea of a complete pathway for electricity is one which needs to be developed through a variety of approaches. As the children review the information that electricity needs a complete pathway to travel on they may see why the bulb does not light. There is a gap in the pathway when the switch is open. Electricity cannot travel across this gap.

As children read page 82 they may find that they made the same mistake in thinking that Jean made, that is, that the switch does not work. This page emphasizes again the fact that electricity requires a complete or closed circuit in order to travel. Have someone close the switch, and when the bulb lights, see if the children understand why. Ask who can show with his finger the complete pathway of the electricity.

The idea of a switch as a convenience also is brought out on page 82. A light may be turned off or on at will with a switch.

Pages 83–84 · Be Safe with Switches

The use of switches in everyday life is discussed on page 83. Probably many children do not stop to think about the part switches play in getting electrical energy to an appliance, or in stopping the flow of elec-

tricity when it is no longer needed. See how many different switches children can mention that are used at home and at school. You may wish to list these uses of switches on the board. Children may be surprised to learn how many switches they use or see used every day.

On page 84 of *Science Everywhere* is added the fact that switches are a safety device as well as a convenience. Some of the consequences of a continuous flow of electricity through appliances are pointed out. The great danger of fire is mentioned. The wear on nerves of continuous noise and intense heat is implied. See if the children can think of other negative effects which might result from such uncontrolled flows of electricity.

Page 85 · Something to Find Out

Page 85 is a "doing page." On it are described four activities which children may carry on to help them gain a better understanding of how electricity works. These activities are placed at the end of a unit for convenience of organization. This does not necessarily mean that they should not be engaged in until the entire chapter has been studied. On the contrary, these experiences will be much more effective if they are used whenever you find they are needed to help children better understand the science meanings being developed.

Materials and Equipment

Materials needed for experiences suggested by *Science Everywhere*:

dry cells, 2 No. 6
electric light bulb of low wattage
objects that are good conductors: e.g., paper clips, steel scissors, knitting needles, tin or silver spoon
objects that are poor conductors: e.g., book, cloth, eraser, glass, string
paper, large sheets
screws, several small
socket, for small electric bulb
string
strip cut from "tin" can
wire, insulated copper doorbell
wood, small block

Materials needed for Additional Experiences and Activities:

bell, electric
cold-water paints
crayons
drawing paper
dry cell, No. 6
objects to test for conductivity
switch, electric
wire, insulated copper doorbell

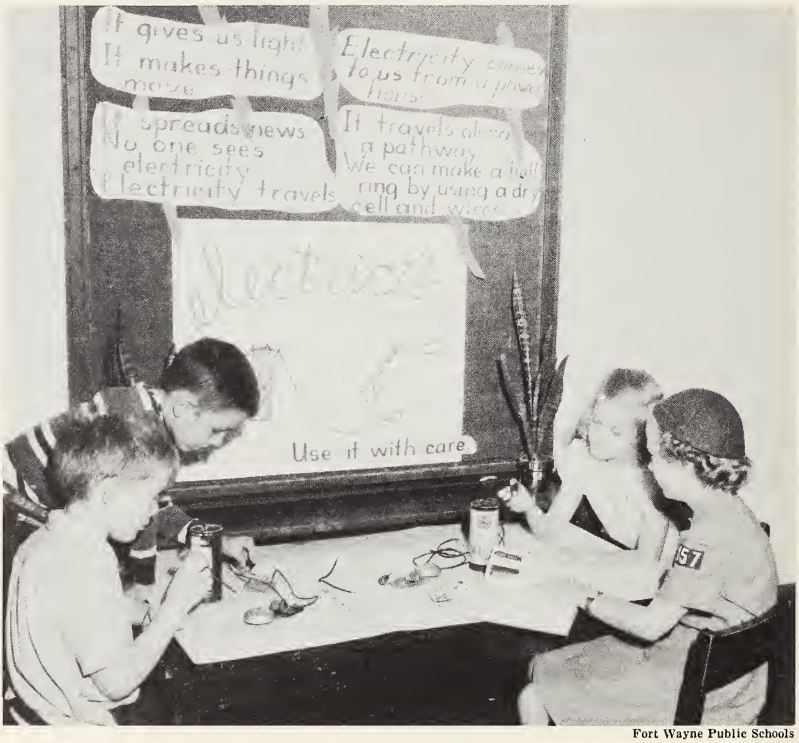
Additional Experiences and Activities

1. Suggest that several groups of children each with dry cell, wire, and an electric bell make a complete circuit. When the circuit is complete, the bell will ring.

2. Another group may carry on from here by cutting one wire. Of course, the bell will stop ringing when the circuit is broken. Then sug-

gest that they put a switch such as the one described on page 81 of *Science Everywhere* into the circuit. Attach the ends of the cut wire under the screws on the switch. Ask the children why the bell does not ring until the switch is closed. If they are not sure, suggest that they look back to page 82 of *Science Everywhere* and use the information there to help find the answer.

3. Have another group of children remove the switch from the circuit


It gives us light
It makes things move
It spreads news
No one sees electricity
Electricity travels
Electricity comes to us from a power house
It travels along a pathway
We can make a bell ring by using a dry cell and wires
Use it with care

Fort Wayne Public Schools

Adding a switch to an electric circuit may serve as a summary experience or as a group activity in connection with reading pages 80–82 of Science Everywhere.

made in the previous exercise. Then suggest that they touch the two ends of the cut wire together. See if the children can tell why the bell rings.

When the two ends of the cut wire are separated once more, suggest that the children place across the gap as many items as they wish to test, one at a time. If a substance touching the two ends of the wire is a *conductor,* the bell will ring. A conductor makes a good pathway for electricity. If a substance is an *insulator,* electricity will not travel through it, and the bell will not ring. Make a list of the items tested that prove to be conductors and another list of those that prove to be insulators.

4. Make a bulletin-board display of pictures drawn by the children showing the different ways we use electricity in daily living.

5. Ask the children to find out, if they can, how electricity is brought to their homes and to the school. See if the wires can be seen from the classroom windows.

Evaluation

How have the children reacted to the activities described in the chapter "Using Electricity"? Were they eager to try them? Did they make suggestions for other related activities? Did all the children participate at some time in some activity? You may wish to keep a record of the participation made by each child in an activity.

Watch for any misconceptions which might have developed in the course of their experiences with electricity. For example, do the children think that there is electricity stored in a dry cell. Do they say the dry cell does not work when really it is wired incorrectly?

Are they gaining some idea of the importance to them of electric power? Can they name some of the places electric power is used at home and at school?

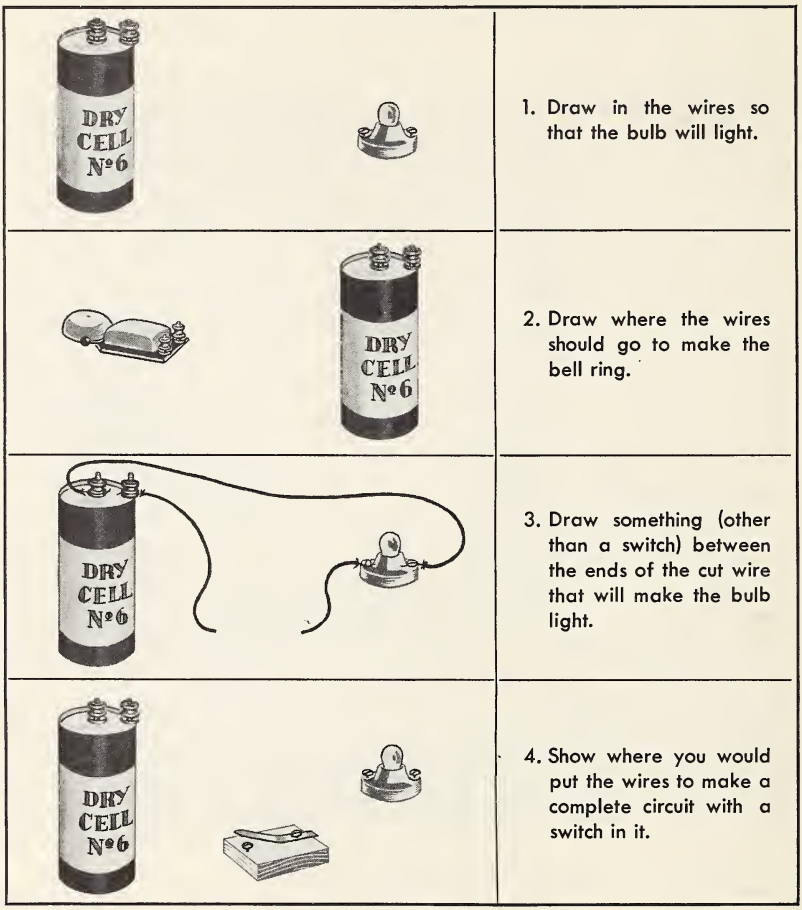
Do they understand what is meant by a complete pathway or closed circuit? Can they draw lines to show the pathway electricity travels on in the circuits they have made? Can they explain how a game such as "Electric Jack Straws" or "Electric Questioner" works?

For evaluating factual learning, completion sentences such as those following might be used. The sentences may be written on the board or duplicated on paper. A list of the words to be inserted in the blanks should be written either on the board or on the paper the children will use, since they are too difficult for most third-graders to spell.

1. An electric pathway is called a (CIRCUIT).
2. An (INSULATOR) keeps electricity within its electric pathway.
3. The two screws on a dry cell which are used for fastening the wires are the (BINDING POSTS).
4. A substance which makes a good pathway for electricity is called a (CONDUCTOR).
5. (ENERGY) is stored in a dry cell.
6. A safe way to turn electricity off or on is to use a (SWITCH).
7. We use (ELECTRICITY) every day to make our work easier.

Diagrams, such as those on page 92, are often helpful in determining a child's understanding of circuits and the flow of electricity. These may be duplicated and the children may then complete each one to show what is requested. The first two diagrams will show whether or

not a child understands what a complete circuit is. In the third diagram, a child's understanding of conductors is checked. The knowledge of the place of a switch in a circuit is evaluated in the fourth diagram.


DRY CELL Nº6
1. Draw in the wires so that the bulb will light.
DRY CELL Nº6
2. Draw where the wires should go to make the bell ring.
DRY CELL Nº6
3. Draw something (other than a switch) between the ends of the cut wire that will make the bulb light.
DRY CELL Nº6
4. Show where you would put the wires to make a complete circuit with a switch in it.

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Films

ELECTRICITY. (Gateway) b/w. Illustrates where electricity comes from and what it does for us. Turbines, generators, motors, closed and open circuits, and switches are explained through homemade experiments.

MAKING ELECTRICITY. (EBF) b/w. Demonstrates how electricity is made by moving a coil of wire through the field of a magnet. Explains how a hand-powered generator is constructed and operated.

Filmstrips

ELECTRICITY. (SVE) b/w. Demonstrates static and current electricity, conductors and nonconductors, and a simple circuit.

ELECTRICITY DOES IT FOR US. (PSP) color. Shows household appliances and communication systems which depend on electricity.

FRICTIONAL ELECTRICITY. (YAF) b/w. Demonstrates by easy-to-do experiments the causes of lightning and thunder.

WONDER OF ELECTRICITY. (EyeGate) color. Art work illustrations show how the utilization of electricity was developed, and its present uses by man.

VII

The Air Around You

The topic of the atmosphere is a large and important one, since air is necessary to life on the earth. A child is surrounded by air from the time he is born, yet he is scarcely aware of the existence of this vital substance. It is the purpose of this chapter of *Science Everywhere* to develop science meanings which will help children understand the importance of air to their existence; to acquaint them with some of the physical properties of air; and to describe some of the phenomena in their environment which depend upon air. "Phenomena" as used in this Manual refers to ordinary, everyday events rather than to spectacular or unusual happenings.

Science Meanings to Be Developed

Children have many experiences every day with the air around them. They feel the wind blow. They hear the roar of the wind during storms. They see clouds and smoke moved by the wind. But they may not think of these things as being related to the movement of air. Since they cannot see air or touch it, many children are not aware of the air around them. However, because air is not only necessary to life and therefore a vital part of the earth, it is also a tremendous physical force. Because of the importance of air to children as well as to all other living things, information concerning "The Air Around You" is included in *Science Everywhere.*

A few of the many science meanings dealing with air are developed in this chapter. If children understand something about air, they will be better able to interpret many of the phenomena which take place in their environment. For example, they will have a better understanding of weather and climate, which depend upon the presence of an atmosphere. Evaporation and condensation, too, should have more meaning for them as they learn how water moves in and out of the air. Knowing that there is air in water will make clearer how animals and plants can live in water. Also as the children learn that there is air in soil and in some rocks they may be better able to comprehend how earthworms, moles, and some other animals can live in the earth without smothering.

These and the other science meanings to be developed in this chapter may be summarized as follows:

The air is a part of the earth.

We live in an ocean of air.

We need air to live.

Air not only surrounds the earth, but it is found in the soil, in water, and in some rocks.

Air takes up space.

Air in some things makes them float.

Air is made of a combination of gases.

When water evaporates, it goes into the air.

Water also comes out of the air. It sometimes comes out of the air as rain.

Water sometimes comes out of the air as snow and as fog.

Information for the Teacher

Children will have ideas and impressions about the atmosphere from their everyday experiences. Encourage them to talk about these ideas. During the warm days of fall or spring, you might plan to spend some time outdoors with your children. Select a place where you can look up with ease at the atmosphere and watch what is going on. Your observations might be guided by such questions as: Are there any clouds in the sky? What kinds of clouds do you see? Are the clouds moving? Is the atmosphere clear? How far can you see? Is the wind blowing? From the answers offered by the children, you may find out what the children think the atmosphere is and whether or not they realize that they are looking through it.

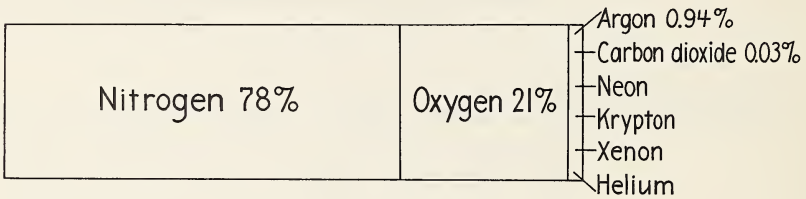
The atmosphere which surrounds the earth makes life on this planet possible. This life-sustaining blanket of air is held to the earth by gravity. The pull of the earth's gravity upon the atmosphere is so strong that air is found in all places on the earth which are not filled with something else. Air penetrates the water and soil of the earth. It is found in the deepest wells and mines. It is found in soil and in some rocks. It is dissolved in the waters of the earth. If this were not so, life as we know it would probably not exist in rivers, lakes, oceans, and soil. Fish and other water animals are able to use the air which is dissolved in water. The many insects, earthworms, moles, and other animals that live in the soil also are able to utilize the air which penetrates and fills the spaces between the particles of soil.

Information concerning the air that surrounds the earth is discussed for children on pages 87–97 of *Science Everywhere.*

The air or atmosphere is not a single, simple substance, but a combination of several gases. Nitrogen makes up about 78 per cent of the air,

and oxygen about 21 per cent. The remaining 1 per cent is composed of argon 0.94 per cent, carbon dioxide 0.03 per cent, and traces of helium, neon, krypton, and xenon. Water vapor and dust also are found in the air in varying amounts at different times. Water vapor and dust, however, are not included in the percentages given here. The bar graph below indicates the relative percentages of the different gases in the air.

Some of the gases in the air are important to living things. *Oxygen* is one of these. When we inhale air, our bodies use the oxygen to produce energy for work and play. Green plants also use oxygen to a limited extent in their growth processes. Plants, however, release much more oxygen into the air than they take from it. In this way, oxygen is being



These gases make up the air around us.

added to the air all the time. Green plants that grow in water also release oxygen. This oxygen goes into the water and provides water animals with this important gas.

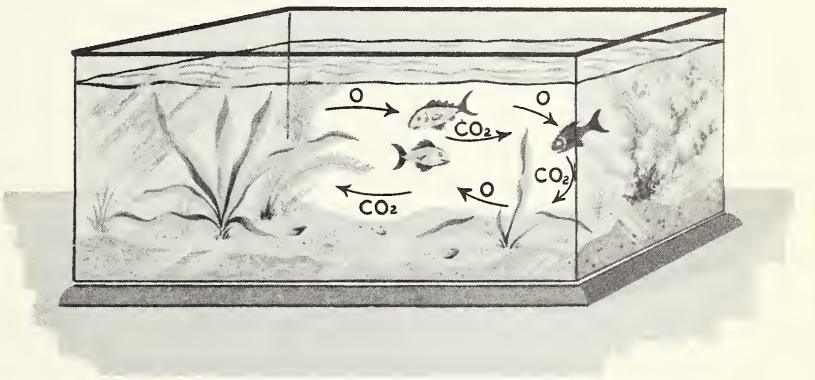
Nitrogen makes up the largest part of the air. It is, however, an inactive gas. It does not combine readily with other substances, as oxygen does. When we inhale, we take nitrogen into our bodies along with the other gases in the air, but we do not use this nitrogen in our bodily processes. We exhale nitrogen into the atmosphere again without having changed it at all. Plants need nitrogen in order to grow, but they cannot use the vast amounts of free nitrogen in the air. They must get the nitrogen they need from soil in which there are decaying plant and animal remains, animal excrement (manure), and nitrates which occur as deposits resulting from evaporation; and from soil in which bacterial action has taken place in the roots of legumes, including peas, beans, alfalfa, and clover. The bacteria in the nodules on the roots of these plants help to replace the nitrogen compounds in the soil where they grow.

Carbon dioxide is another gas found in air. It is present in a minute amount. Only three-tenths of 1 per cent of all the air is carbon dioxide. Yet this gas is important to living things. Green plants manufacture food from carbon dioxide, water, and sunlight. This process makes possible all of man's food supply, since all animals, including man, depend either directly or indirectly upon green plants for food. Scientists have

not yet been able to duplicate the food-making process which goes on continuously among green plants. When plants decay they return carbon dioxide to the air.

The respiration of many animals, again including man, results in the release of carbon dioxide into the air. This is just the reverse of what takes place with green plants. Plants release oxygen as a waste product. Animals use the oxygen given off by green plants and in turn release carbon dioxide as a waste product. Plants use the carbon dioxide given off by the animals, then release oxygen to be used in turn by animals as the cycle continues. This process is known as the oxygen-carbon dioxide cycle.

The oxygen-carbon dioxide cycle may be seen in operation in most aquariums. The green water plants produce oxygen in the water. The fish breathe the oxygen and release carbon dioxide as a product of respiration. The green plants use the carbon dioxide and release more oxygen. And so the cycle continues.



The illustration above shows the movement of oxygen and carbon dioxide in an aquarium. O stands for oxygen; CO_2 stands for carbon dioxide.

The other gases in the air occur in exceedingly small amounts. They are known as rare gases. They include argon, neon, krypton, and xenon. These gases, like the nitrogen in the air, are inactive and are not known to affect living things. Children may be familiar with the word *neon,* since neon is the gas used to produce the bright colors in many electric signs. Some children may also have heard of helium in connection with lighter-than-air craft, such as dirigibles and balloons. The helium used in these aircraft, however, comes from natural gas deposits in the earth rather than from the air.

The gases which make up the air are discussed for children on page 92 of *Science Everywhere.*

The air around the earth is made up of layers which merge, one into the other. Because of the gravitational pull of the earth, the layer of air near the earth's surface is denser than that at higher altitudes. We live in this denser portion of the atmosphere, which extends from the surface of the earth to a height of 6 to 10 miles. This region of the atmosphere is called the troposphere. All of the weather phenomena which we ordinarily experience occur in the troposphere. It is a region of great weather changes. It is in this region of the atmosphere that rain and snow fall, that fog and clouds appear, and that variable and shifting winds blow. It is the portion of the atmosphere with which we are most familiar. Indeed, most people never leave the troposphere.

Above the troposphere is a layer of atmosphere known as the stratosphere. This layer extends to a height of approximately 50 miles. Children may know the term stratosphere, since it is used in connection with aircraft. Some passenger planes are called stratoliners. A stratojet is a type of fighting plane. Other planes are called stratocruisers. In these instances, the names of the aircraft indicate the region of the atmosphere in which they travel. One of the advantages of flying in the lower stratosphere is that the winds there are usually of less velocity than in the troposphere.

Above the stratosphere is the ionosphere. This layer of air is of interest to radio engineers, since it is within this layer that radio waves are turned back to earth, thus making radio communication possible.

In man's search for greater knowledge of the atmosphere he has flown an airplane as high as 15 miles, and has succeeded in sending rockets as high as 250 miles. It is now generally accepted that the atmosphere extends to a distance of 10,000 miles or more.

As was indicated in an earlier paragraph, water vapor and dust are present in the atmosphere in some degree all the time. Dust is blown into the air by the wind and carried to high altitudes by ascending air currents. It is dust in the air which scatters the light from the sun and produces colorful sunsets.

The amount of water vapor in the air does not remain constant very long. Water continuously goes into the air and comes out of it. Water goes into the air by *evaporation.* It evaporates from ponds, lakes, rivers, and oceans, from sidewalks, streets, roof tops, fields, and woods, after a rain. It evaporates from the leaves and stems of plants and from the bodies of animals. When we exhale, we breathe water into the air. The fact that water goes into the air from many places is discussed on page 93 of *Science Everywhere.*

Water comes out of the air by *condensation.* When there is more water in the air than the air can hold, water comes out of the air. It often comes out as rain. If the air is cold enough, the water vapor freezes and ice crystals form. Then water comes out of the air as snow. Sometimes water condenses out of the air but the water droplets which result are not large enough or heavy enough to fall to the earth. Then we can see water in the air as clouds. Clouds sometimes form so low that they touch the earth's surface. Then they are called fog. Pages 94–95 of *Science Everywhere* present the ways water comes out of the air.

The movement of water in and out of the air is important to living things. If water could not come out of the air, there would be no rainfall or snowfall. In other words, no water could come to the earth from the air. When all the water in the existing lakes, rivers, and oceans was exhausted, plants and animals would soon die. Suppose now that water could not go into the air. The oceans, lakes, and streams would soon be filled to overflowing and water would cover the earth. This would be disastrous, too.

Fortunately for us, however, water is always on the move in and out of the air. Water goes into the air by evaporation until the amount of water vapor in the air increases to such an extent that the air can no longer contain it. Then water condenses out of the air and falls to the earth to be evaporated once more. This continuous movement of water in and out of the air is known as the water cycle. A water cycle is shown in the illustration on page 96 of *Science Everywhere.*

Ways of Working with Children

Before the children begin to read "The Air Around You," it might be well to discuss with them certain things about air. As children express their ideas you may gather clues about their patterns of thinking, and learn where the children are in their understanding of the earth's atmosphere. You will be able to ascertain what correct information and what misconceptions they have about the air. You may learn whether they rely on fancy and imagination to explain such phenomena as snow, rain, clouds, and evaporation, or whether they seek scientific information to explain these things.

A discussion of air might be started by asking, "What is all around you, and inside you, yet you cannot hold it, or see it, or taste it?" When replies are made, have the children check them to see if they fulfill all the specifications of the question. As they learn that the substance referred to is air they may turn to pages 86–87 in *Science Everywhere* to find out more about the air around them.

Page 87 · Living in an Ocean of Air

On page 87, air is described as an ocean. An "ocean of air" is probably a new idea to many children. The idea that there is a top and a bottom to the atmosphere may also be new to them.

As children read page 87 they find that air is all around them, in their eyes and ears, and in their mouths. Before they turn to page 88, you might ask: In what other places do you think you would find air? Encourage children to express their ideas. Whether they are correct or incorrect does not matter at this point. Their answers will guide you in helping the children acquire accurate information. You or one of the children may wish to list on the board all of the places where children say that air may be found. Some responses may be guesses. This is all right. Guesses are the first step in the formation of an hypothesis. When the children have exhausted all the places they can think of where air can be found, have them turn to page 88 to read about air in soil.

Pages 88–90 · Air in Many Places

Some children may think that soil is solid, and may wonder how air can get into something apparently as solid as soil. It would be appropriate at this point to look at a spoonful of soil with a hand lens or magnifying glass. The children will see that soil is composed of tiny individual particles. These particles may be seen as the soil is touched with a finger or pencil point. There are spaces between the soil particles and it is in these spaces that the air in soil is found.

As children perform the experiment on page 88 call their attention to the bubbles that form when water is poured on the soil. These are air bubbles. Water cannot get into the spaces between the soil particles until the air that is in these spaces is pushed out. Sometimes water does not go into soil quickly. This is particularly true when soil is very dry or has recently been disturbed, as would be the case with a freshly filled flowerpot. If such soil as this is used for the experiment on page 88, pour water into the container very slowly. Then wait a few minutes between the additions of more water. Bubbles of air will form, come to the surface of the water, and burst. Then water will sink into the soil.

Try this experiment with well-settled soil in a flowerpot in which a plant has been growing and which has been watered, and then with a flowerpot newly filled with dry soil. Ask the children to note into which soil water goes more readily. Do they know why? If not, you may explain that there is much more air in dry, loose soil than there is in damp, compact soil. There are more and sometimes larger air spaces in dry soil. Much more air must come out of dry soil than out of damp soil before water can go into it.

The presence of air in water is discussed on page 89. Here is another place where children might not have thought air could be. They may have experienced getting water up their noses when swimming or when washing their faces. They remember these experiences as unpleasant ones because they could not breathe. They could not get air. They may be skeptical, therefore, of the statement that there is air in water.

The experiment on page 89 of *Science Everywhere* explains how children may see air in water. When the water is heated for this experiment, it should not reach the boiling point. Air comes out of water as it is warmed. But when water boils, it is steam, not air, that comes out of the bubbles. In this experiment, the object is to show children that there is air in water and that this air can be seen in the form of bubbles.

Air is dissolved in water, and thus is not in a form which can be used by our bodies. That is why we choke and cough when we get water in our noses and other breathing apparatus, even though there is some air in water. We not only need more air than is found in water but we also need air in a different form. The air dissolved in water can be used, however, by fish, aquatic snails, crabs, shrimps, oysters, sponges, and the many other animals which spend their entire lives beneath the surface of water.

Two other places in which air is found are described on page 90. For example, there is air in some rocks. Pumice is one such rock. In its formation, gases bubbled through it while it was still in a molten state. As the pumice solidified these openings remained, giving the rock a spongy appearance. Air filled these openings so that when a piece of pumice is placed in water and water pushes into the openings, the air is forced out of them. Air can be seen coming out of a piece of pumice in the form of bubbles as the pumice is held in a container of water. If possible, have your children try the experiment with pumice.

There is air in a sponge, too. The second experiment on page 90 may be performed with a natural, rubber, or plastic-fiber sponge; the result will be the same with each. Air fills the many openings in a sponge. Therefore when a sponge is immersed in water, the water goes into the openings, and the air that was in these openings is pushed out. This air is seen as bubbles which rise to the top of the water and burst.

The question at the end of page 90, "Can you think of other spaces that air fills?" is included as an encouragement to children to experiment further to find spaces that air fills. For example, they might try experiments that show there is air in a piece of dry wood, in "empty" boxes, bags, jars, and other containers. Only a few of the many places filled with air are mentioned in this chapter. See how many others your children can find.

Page 91 · Air Makes Things Float

On page 91, air and its relation to floating are described. The air trapped in spaces in some materials acts as a buoy to make them float when placed in water. It is the air in pumice and a sponge that makes them light enough to float. As long as air fills spaces in these materials, water cannot fill them. If the air were removed from these spaces water could enter and the sponge and pumice would sink. You will note that a sponge gradually floats lower in a container of water as water fills some of its spaces. It usually will not completely sink, however, since air remains in enough of its spaces to keep it afloat.

The experiment described in the last paragraph of page 91 provides a "before and after" situation for the purpose of contrast. This is a dramatic way to show that the air in some things makes them float. Of course, the deflated balloon sinks because water enters the open end and pushes the air out. When the balloon is inflated and the end is tightly closed, air is held inside the balloon, and water cannot enter to push it out. Then the balloon floats. On page 97 of *Science Everywhere* another "floating" activity using several objects is suggested. Children may wish to try that experiment at the same time they are reading and doing the experiments on page 91.

Page 92 · Air Is Made of Gases

The fact that air is a combination of gases is introduced on page 92. To begin the development of the science meaning *air is made of gases*, you might ask: What is a gas? Some children may think of gasoline for automobiles as a gas. Others may know of gas as a fuel for heating their homes and for use in the kitchen stove. Still others may be familiar with the term "poison gas" as they have heard it discussed by adults on radio and television, and in the movies.

The idea that the air they breathe is made of gases may be new to some children. It would be wise to take adequate time at this point to make certain that children understand the properties of a gas. A gas is usually colorless, may be tasteless and odorless, and is invisible and intangible. It should be explained that gasoline is not a gas, since gasoline is a liquid and can be seen and touched. It is spoken of as "gas" only because the word happens to be a shortened form of the word "gasoline."

Natural gas for heating and cooking is a real gas. It is odorless, tasteless, and invisible. For safety, a scent is added to natural gas so that leaks may be located quickly, and escaping gas shut off before explosions or asphyxiations result.

The gases of which air is composed are odorless, tasteless, and invis-

ible. Although these gases are seemingly nonexistent from a child's point of view, they may be identified, since they act in different ways. Oxygen is one of the important gases of the air. Its importance to living things is emphasized earlier in this chapter and on page 92 of *Science Everywhere.*

You may wish to discuss carbon dioxide, another important gas. Although this is not referred to in *Science Everywhere,* it has some everyday uses with which children may be familiar. For example, it is used by plants in their life processes. It is used in carbonated drinks. Carbon dioxide is effective in slowing down burning and is therefore used in fire extinguishers. A type of carbon dioxide foam is used to extinguish gasoline and oil fires. Dry ice is solid carbon dioxide.

Nitrogen, argon, krypton, and xenon are such inactive gases that the children in your class probably have little or no knowledge of them. Helium and neon may be known by some children.

Water vapor, which is an important part of the air, is water in the air in a gaseous form. When water evaporates, it goes into the air and becomes water vapor. Attention might be called to the word "vapor" in the middle of "evaporate." This may help children to remember the relationship between evaporation and the presence of water vapor in the air.

Page 93 · Water Goes into the Air

Water goes into the air from many places. Some of the sources of water vapor are mentioned on page 93 of *Science Everywhere.* Encourage children to name other places from which water evaporates into the air. Also invite them to share with the group experiences they have had with this phenomenon. Evaporation is first introduced in the textbook on pages 48 and 49 in the chapter "Changes All About You." It might be well to have children turn to those pages and review the process of evaporation. The evaporation referred to there is exactly the same phenomenon as that discussed on page 93. Evaporation is the only way in which water can get into the air.

Children may wish to repeat the first experiment on page 63 of *Science Everywhere* in connection with their study of evaporation in this chapter.

Pages 94–95 · Water Comes from the Air

On pages 94 and 95 of the textbook the reverse of evaporation is discussed. When water comes out of the air, it is the result of a process known as condensation, which was discussed earlier in this chapter of the Manual.

It is sometimes easier for children to understand how water comes

out of the air than how it evaporates into the air. Rain, snow, sleet, hail, fog, and clouds are all visible evidences of condensation which children can readily see. When moisture-laden air is cooled, the water in the air condenses and often falls to earth as precipitation. At other times, condensed moisture in the air is visible as clouds or fog.

Page 96 · Do You Remember?

The illustration on page 96 is designed to show the movement of water in and out of the air by evaporation and condensation. Since this movement of water, or the water cycle, is important to all living things, it is important that children realize its significance. With the aid of the information summarized on page 96, children may wish to illustrate the various places from which water goes into the air. They may also show the ways in which water comes out of the air. It might be interesting for them to trace the movement of a drop of water from the time it comes to earth as rain until it is evaporated into the air and ready to be precipitated again.

Page 97 · Some Things to Try

An experiment which children may do to see condensation at close range is described in the second paragraph on page 97 of the textbook. Children may wish to repeat this experiment several times to be sure that the cup does not leak, or that someone did not spill water on the outside of the cup. In other words, they may wish to convince themselves that the water on the cup could not possibly have come from any other place than from the air. A similar experiment is suggested on pages 106–107 of the Manual.

Materials and Equipment

Materials needed for experiences suggested by *Science Everywhere*:

coffee can or other container for soil
garden soil, dry
heat source, hot plate or stove
ice cubes or ice water
objects for experimentation: e.g., balloon, block of wood, crayon, marble, paper clip, pebble, penny, pumice, sponge, tack
pan or bowl
paper, drawing or chart
saucepan, glass
tin cup
tumbler
water

Materials needed for Additional Experiences and Activities:

aquarium or deep glass dish
asbestos pad
bottle with narrow neck
cardboard trough
candles, birthday size
cork
crayons or water paints
dry ice

funnel to fit bottle with narrow neck
jar, 1-quart
jars of varying sizes
matches, small box
mirror or small piece of window glass
paper, drawing or chart
pliers or small tongs
thermometers, 2
tumbler
wastepaper

Additional Experiences and Activities

1. Demonstrate that air takes up space. Hold an "empty" glass or bottle upside down in a pan or an aquarium filled with water. If the glass is pushed straight down and not tipped, water will not go into it. Water *cannot* go into the glass until air comes out. In reality the glass is not empty, but *full* of air.

To prove that no water enters the glass, have someone feel the inside of the glass after trying the experiment and tell whether it is wet or dry. (It should be dry.)

A dramatic way to show that no water enters the glass is to wrap matches in paper and crumple the paper so that it stays in the bottom of the glass. Push the glass down into the water in the same way as before. Then remove the wad of paper and light it with the matches. Because the air took up so much space in the glass, there was no room for water to enter. The air in the glass kept the water out, and the matches remained dry.

Another variation of this experiment may be tried with a quart jar instead of a glass. With hot wax, attach a small birthday candle to a slice of cork sufficiently heavy to balance the candle so that it does not upset. Then float the cork on the water, and light the candle. Push the jar down over the candle and cork to the bottom of the pan or aquarium. Then raise it carefully. The candle will still be burning, showing that no water entered the jar. Remember that fire needs air to burn and that the amount of air in a quart jar is limited. Therefore the candle may use up the oxygen in the jar and go out if too much time is consumed in performing this experiment.

2. Demonstrate that fire uses oxygen in the air when it burns. Place several short candles in a row on an asbestos pad or other fire-proof surface. Near each candle place a jar, each of a different size. Have a child stand ready to place a jar over each candle at a given signal. Light the candles. At the word "Go" ask the children to place the jars over the candles, then watch to see which one goes out first and which burns the longest. The candle under the largest jar should burn longest because more oxygen is available in a large jar than in a small one.

If the schoolroom clock has a second hand that can be seen easily, another group of children may wish to watch to see just how many seconds each candle burns.

Try this experiment over immediately with the same jars. Time the burning periods of the candles again. Ask the children to find out whether they burn a longer or a shorter time now. Do they know the reason for the difference? You may need to explain that most of the oxygen in the jars was exhausted when the experiment was first tried.

Jars, glass bowls, and candles from mother's kitchen provide all the equipment necessary for this effective science experiment.

Madison Public Schools, Madison, Wisconsin

The only oxygen left in the jars at the time of the second experiment was that which entered as the jars were moved about between demonstrations. The candles will probably not burn as long this time, since there is less oxygen in the jars to support combustion.

3. Demonstrate that air is necessary for us to live. Suggest that each child hold his breath for a few seconds. The children will quickly see what a very short time they can do without air.

4. Demonstrate that water comes out of the air. Have someone breathe on a piece of glass or a mirror. Droplets of water will appear on

the glass surfaces. This water came out of the air. See if the children recognize that the same thing happens in this experiment that happened in the experiment with the tin cup described on page 97 of the textbook. Both experiments show condensation.

Have children note the water on windows in the kitchen on a cold day. Those children who wear glasses are aware of the way their lenses steam up when they go from the cold outdoors into a warm room. The water droplets on their glasses also are water that has come out of the air.

5. Illustrate the oxygen-carbon dioxide cycle. The children may wish to illustrate the movement of oxygen and carbon dioxide among plants and animals in an aquarium. They may use drawings including arrows as in the illustration on page 97 of this Manual.

6. Illustrate clouds in the air. Children are often fascinated by clouds —by the way they look and how they move. They wonder where they come from, and where they go. They may wish to find out something about the various shapes clouds assume, and the type of weather these shapes usually indicate. They may wish to make pictures of the four main types of clouds, namely, cumulus, cirrus, stratus, and nimbus.

7. Record the temperature changes of the air. There are daily variations in the temperature of the air. These variations are indicated by a thermometer. Have the children note the difference between classroom and outdoor temperatures by reading thermometers. A committee might record daily temperatures at 9:00 A.M. and 3:00 P.M. every day for a week. They may want to make a chart showing the highest and lowest temperature recorded, and the greatest temperature variation recorded in any one day. You might ask them to think of as many reasons as they can why it is important to know the temperature of the air.

8. Show when an "empty" bottle is not empty. Place a funnel in the narrow neck of a pint bottle. Try to pour water fairly rapidly into the bottle. Ask the children why the water will not go into the bottle faster. Perhaps they will know that there is air in the bottle and that the water cannot go into the bottle until the air comes out.

Then lift the funnel slightly so that there is a space between the funnel and the neck of the bottle and try again to pour water into the bottle. Ask the children to notice that the water then goes into the bottle easily because raising the funnel permits the air to escape from the bottle as the water enters.

9. Demonstrate that carbon dioxide may be used to put out fires. A simple and dramatic experiment may be done to show the fire-extinguishing property of carbon dioxide. With tongs or a pair of pliers, place a small piece of dry ice in a quart jar until it has vaporized. Since dry ice is solid carbon dioxide, the vapor formed is gaseous carbon dioxide.

Attach several pieces of birthday candle to a cardboard trough as shown in the drawing. A shoe box with the ends cut out or a paper-cup container with the ends and one side cut out may be used. Arrange the trough with the candles attached so that it slants as illustrated. Light the candles. Then pour the carbon dioxide vapor down the trough, as though water were being poured from the jar. As the carbon dioxide vapor reaches each candle it will put the flame out.

Evaluation

When children have performed experiments and have become fairly proficient in handling materials, they often enjoy doing some experiments many times. Some of the children may wish to perform certain suggested experiments for another class. This activity provides an excellent opportunity for review and should be encouraged.

In some instances, it is worth while to invite another class of the same or an adjacent grade level to hear reports made by individuals or groups on topics dealing with air. Preparation of the reports also furnishes an incentive for review and summarization.

Another activity which might be used for evaluating the learning which has taken place in the study of air is writing stories. Children might write an imaginary story of what the earth would be like if water could not come out of the air. Or they might write about what would happen if water could not go into the air.

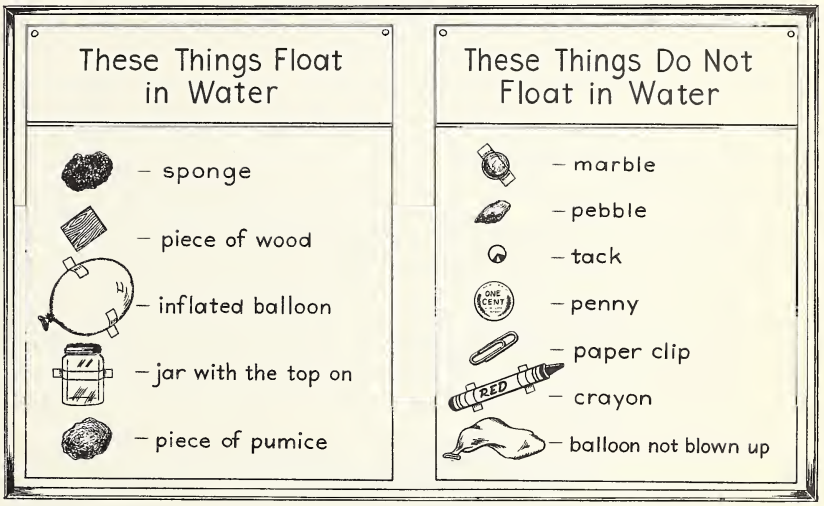
Making simple charts for a bulletin-board display is a good way to

help children clarify and crystallize some of their science learnings. You might suggest that the children:

Make a simple pictorial chart to show the oxygen-carbon dioxide cycle in a place other than an aquarium. Use arrows to show the movement of these important gases.

Make a pictorial chart using arrows to show how water moves in and out of the air.

Make several summary charts. Two such charts might be entitled "These Things Float in Water" and "These Things Do Not Float in Water." Sample objects may be attached to the charts with scotch tape or rubber cement.



Art activities may also be used in evaluating children's learnings. For example, children might show by means of pictures:

a. Their ideas of the atmosphere
b. The relationship of the atmosphere to the solid part of the earth
c. Differences in the appearance of the atmosphere on different days

You may at times wish to check the children's comprehension of the factual knowledge presented in a chapter. This may be accomplished by using a series of true and false statements, such as the following:

(*T*) We live in an ocean of air.
(*F*) We can use the air that is in water.
(*F*) There is air above the earth only.
(*T*) There is air in soil and in some rocks.

(*T*) Air fills all spaces which are not filled with something else.
(*T*) Water can move in and out of the air.
(*T*) Some things float because there is air in them.
(*F*) Plants give off much carbon dioxide.
(*T*) Air is made of more than one gas.
(*T*) Water may come out of the air as snow.

In each of these statements, the correct answer is indicated.

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Films

LIFE IN AN AQUARIUM. (YAF) b/w. Explains how fish breathe under water and that all animals need oxygen.
NOTHING BUT AIR. (IF) b/w. Daily experiences demonstrate that air occupies space, is all about us, has weight and power.
WATER CYCLE. (EBF) b/w. Tells the story of the water cycle, beginning with evaporation into the atmosphere, condensation, and falling as rain.
WATER, WATER EVERYWHERE. (Cor) b/w and color. A young boy learns about evaporation, how clouds are formed, and why rain falls.
WHAT MAKES RAIN? (YAF) b/w. Presents in simplified manner the explanation of the water cycle. Terms are carefully explained as they are introduced.

Filmstrips

WATER CYCLE. (Dowling) b/w.
WEATHER. (YAF) color.
WE LEARN ABOUT THE WEATHER. (PSP) color.
WHAT AIR DOES. (VS) color.
WHAT AIR IS. (VS) color.
WHAT AIR PRESSURE IS. (VS) color.
WIND. (FH) b/w.

VIII

The Earth You Live On

From the time a child is born he begins to examine his surroundings in an effort to orient himself to his environment. At first, his world is limited to his crib. Later, as he crawls about his world is materially enlarged. With his first steps in an upright position, he not only covers more distance, but he sees farther than when he was creeping. Gradually throughout his early life he becomes more and more aware of the world in which he lives. He learns that the world extends beyond his yard. He finds that there are other streets something like the one he lives on, other trees and gardens, other hills and meadows, other woods and forests, other farms and ranches, other towns and cities than those near his home.

By the time he has reached the age of eight or nine, a child usually has learned that the world in which he lives has a name. It is called the earth. He usually has learned that the earth is round. But his space concepts are rather limited, so he probably has little idea of the size of the earth. Most children know that the earth is "big," but they are not sure just how big. And they do not know what the earth is like in places they cannot see, or in places they have not visited.

The chapter "The Earth You Live On" in *Science Everywhere* is designed to help children become more familiar with the earth. In this chapter are presented some of the earth's many geographic features. The size of the earth is described in connection with traveling. In an indirect way, some of the different climatic conditions of the earth are given. The idea of great variety is again emphasized in this chapter: variety in topography, variety in climates, and variety in the resulting plant and animal life in different regions of the earth.

Science Meanings to Be Developed

Most children eight and nine years old have a limited understanding of space and distances. They know best about their immediate environment; they know the way to and from school, the store, a nearby favorite play area. They may know the distance in miles from their house to a downtown shopping district or how far it is

to the next town, but beyond these their understanding of space and distance becomes increasingly vague. The idea of a hundred miles may have some meaning to a child who has traveled that distance. But a thousand miles or twenty-five thousand miles usually means little to children of this age because they have little way of relating such distances to something in their own experience.

"The Earth You Live On" is planned to help children translate the vast size of the earth into terms which they can understand. It is hoped that the children will enlarge their ideas of what the earth is like as they find out about the great variety of surface features on the earth, and as they learn about the earth in places which they cannot see at firsthand.

The following science meanings are developed in this chapter:

There is great variety in the geographic features which make up the earth's surface.

Mountains, deserts, islands, and plains are geographic features of the earth's surface.

Lakes, streams, rivers, and oceans also are geographic features of the earth's surface.

Rocks and soil are part of the earth.

Plants are a part of the earth.

Waterfalls, geysers, and canyons are part of the earth.

The earth is very large.

The earth is much too big to be seen all at one time.

A map is useful in finding out certain things about the earth.

A globe is a kind of map.

The earth is round.

A globe is round like the earth.

The land and water areas of the earth can be shown on a globe.

Information for the Teacher

Since the chapter "The Earth You Live On" suggests many topics for discussion, you will wish to have sufficient information to judge the accuracy of the ideas presented. Following are data that should provide helpful background information.

The opening pages of the chapter indirectly indicate the great size of the earth as they mention its many different regions. Obviously, the earth is large if there is space on it for mountains, lakes, oceans, deserts, plains, beaches, islands, and rivers. The earth is large when compared with everything else in the experience of children. It is larger than their houses, their farm, the block they live on, their city, or even their country. The earth is the largest thing with which children are concerned.

It would be well to review some of the surface features of the earth which children may be discussing. Geographers speak of mountains, hills, plateaus, and plains as types of landscapes, which they group into rough areas and flat areas. Geographers also distinguish between mountains and hills on the basis of elevation. But adults as well as children are more likely to refer to the local regions as hills or mountains in accordance with local custom, rather than on a scientific basis. For example, a mountain to one child may mean a high, snowcapped peak, to another a rocky elevation, to others a forested hill, and to still others a smoking volcanic cone.

The flat places vary in reality as much as do the connotations of the words. They include plains that have been formed by the wearing down of rough surfaces as a result of erosion of wind and water and by glaciers, and by the building up of water areas with the debris and silt brought into the area by rivers. They are found too where seas and lakes have dried up.

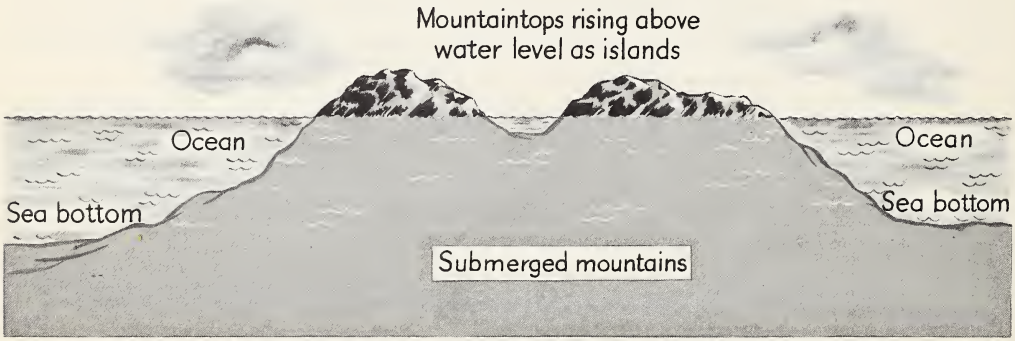
Rolling treeless areas characterize certain plains, but there are also flat areas that are well wooded. Desert plains include those portions of the earth's surface that cannot support inhabitants because they are either ice wastes, tundras, llanos or steppes, or arid wastes in areas of minimum rainfall.

The surface features of the earth, along with the climate and soil properties, help to determine the vegetation found in the different areas of the earth. On our continent, for example, many forests grow in the mountainous regions. But forests vary, too. Those in the high mountains near the timber lines, the uppermost extension of forest growth, for example, are usually made up of trees that are bent, twisted, and often prostrate because of the force of the wind at such altitudes. On the lower slopes of some mountains, there are forests of coniferous trees (trees bearing cones), such as pine, spruce, hemlock, cedar, and juniper. In the cooler parts of the temperate zones, these evergreens are found at lower altitudes. The forests that grow in fertile valleys or in foothills are more likely to be made up almost entirely of deciduous trees (those that drop their leaves each fall), such as the maple, oak, beech, hickory, ash, elm, sycamore, and cottonwood. In tropical areas on mountains and in the valleys, mahogany, palms, and mangrove, which are neither deciduous nor coniferous, are most abundant.

Grass and sage and other small shrubs grow on the drier areas of the rolling plains of central North America and constitute the grazing land for cattle and sheep ranches located there. The nearby cultivated plains produce most of the nation's grain. Coastal plains and the level valleys between the mountain ranges and along the larger rivers are character-

ized by a diversity of farms. Chicken, dairy, and other stock farms, fruit and truck farms, and farms producing grain, cotton, and tobacco are among those with which children will probably be familiar. Some of these farms may even be located on the islands formed in the rivers, lakes, oceans, or gulfs bordering the level farm land.

Again the word *island* will doubtless have many meanings for the children in your classroom. To some it may bring to mind the tree-covered hilltop out in the lake where summer picnics are held, and to others a resort in the ocean visited by tourists living in luxurious hotels. A few may know that an island can be as large as the continent of Australia and as small as the boggy area that changes the current of the smallest river.



"Many of these [islands] are the tops of hills, mountains, and larger land masses that have been submerged. Most of the islands off New England and the British Isles were so formed. Others, including Bermuda, the Azores, many of the smaller West Indian islands, and the majority of the smaller Pacific islands, including the Hawaiian group, are volcanic cones built up on the sea floor. Smaller islands are sometimes formed by the rock residuals left by wave erosion, and by deposits in the form of bars." [1] In the sketch above, two islands are shown in cross section.

The problem of presenting the physical features and other landmarks of the earth in a manner that would make it possible for people to visualize and study them at great distances has been a concern of explorers, travelers, geographers, and others for centuries. The very size of the earth has been one of the problems in accurate map making. To

[1] C. R. Longwell, Adolph Knopf, and R. F. Flint, *A Textbook of Geology*, Part I (New York, John Wiley & Sons, Inc., 1939), pp. 213-214.

examine the whole earth at sufficiently close range to prepare accurate maps has required the work of countless men and years of time.

Map making appears to have been not only a recognized need but also an accomplishment of men from the earliest times. Even primitive peoples have drawn maps of large areas with accuracy. The Indians and Eskimos of America and the peoples of the South Seas, for example, prepared excellent maps. The earliest maps which are still in existence were made by the ancient Babylonians. As long ago as 150 A.D., Marinus of Tyre, a Phoenician, prepared an eight-volume *Geography* in which he presented twenty-seven maps of smaller areas and a map of the then-known world. During the Middle Ages, regularity of design more than accuracy appealed to the men of the time, so that their maps added little to the knowledge of the earth. With the discovery of America, map makers were confronted with the problem of showing the relationship of the new continent to Asia, much of which itself had not been mapped, as well as to Europe.

The oldest map entirely produced and published in America was printed from a woodcut made by John Foster of New England in 1677. The first large city map in America was made by Bonner of the city of Boston in 1722. Washington's surveyors later participated in the cartography of the new country. During the early 1800's, maps in America were prepared under the auspices of the Army by such men as William Clark of the Lewis and Clark expedition, and Charles Frémont who explored and mapped sections of the West. It might be interesting to compare one of the early maps with those used in schools today. Copies of many early maps are given in the *Encyclopedia Americana* and the *Encyclopaedia Britannica.*

Official agencies presently charged with map making for our country include the United States Corps of Engineers, the United States Coast and Geodetic Survey, and the Geological Survey. In recent years map making has been aided significantly by airplane photography.

With all the newer methods and knowledge of map making, most maps are flat and do not look much like the global earth. It is not surprising that children have difficulty in seeing the relationship of a map to actual places they have visited. When a map is superimposed on the spherical surface of a globe, however, it resembles a miniature earth and is usually more interesting to and easily understood by them than a map. With the aid of a globe and the illustrations in *Science Everywhere* along with a wall map, perhaps you can help your children to translate the surface features of the earth as shown on the globe into the mountains, hills, plains, and valleys they have actually seen.

Ways of Working with Children

The illustrations opening the chapter "The Earth You Live On" may be used as a basis for a discussion of the earth's appearance in different places. You might ask the children what they think the earth is like. Those children who have traveled widely may have much to contribute about the appearance of the earth in other places. Those who have lived all their lives in one locality may have detailed information to contribute about their immediate environment. Allow ample time for children to present their ideas.

You may wish to have children express their ideas of the earth in drawings or paintings before reading this chapter. The drawings will indicate what children think about the appearance of the earth's surface. They will indicate whether the children consider water a part of the earth. They will indicate also by the inclusion of clouds and evidences of wind whether the children understand that the atmosphere with its weather phenomena is a part of the earth.

Pages 99–100 · What the Earth Is Like

After children have had an opportunity to tell and show what they think the earth is like, ask them to read together pages 99–100 of *Science Everywhere* to learn what other children think the earth is like. You may wish to guide them in their learning by asking:

How many different types of places are mentioned on these two pages? (The six are: mountains, deserts, forests, plains, farm lands, and ocean beaches.)

Do your pictures show any of these parts of the earth?

Have you ever seen any of these other parts of the earth?

What is the earth like where you live?

Pages 101–105 · The Land You Live On

This section discusses and describes in some detail several specific regions of the earth. It is hoped that children will gain from these pages some understanding of the great variety in the earth's appearance in different places. Many different regions are presented so that children from many localities may be able to identify themselves with one or more of the regions described.

Dick's home near one kind of desert is described on page 101. You might ask your children what they think it would be like to live on the desert. Some may say that they would expect to see nothing but sand. Others might expect to see camels. Some children may think of cacti as a dominant feature of desert scenery. Many may say that a desert is a

dry place. If someone in the class has visited a desert or has lived there, encourage him to describe what a desert is like.

Have the children read page 101 and then compare their ideas of a desert with the one described here. The extreme dryness of such areas should be brought out. The difference between a region of lush, green vegetation and a desert is largely the difference between the availability of water and the lack of it. Plants and animals found in desert regions have adaptations which enable them to survive with a limited water supply. Such animal adaptations include leathery hides, thick shells, and the ability to exist on the moisture contained in the green plants they feed upon rather than having actually to drink water. Among plants also which grow in desert areas there are adaptations, including the reduction of leaf size, often to a spine or thorn; leathery or waxy surfaces on leaves and stems to reduce water loss; special cells within plants for water storage; and a root system which can absorb moisture rapidly when it is available.

You might ask the children: What animals do you know that can grow in the desert? Perhaps they will wish to talk about some of the adaptations of the plants and animals familiar to them.

Page 102 shows a region which contrasts sharply with the desert described on page 101. Jean's home is in a forest near the ocean where there is abundant rainfall each year. There is much moisture in the air as the wind blows in from the ocean. Fog occurs frequently. This moist atmosphere makes possible the large ferns, many kinds of mosses, and the tall redwood trees and other conifers which thrive in the moist habitat near Jean's home.

Have the children find as many differences as possible between the way the earth looks where Dick lives and where Jean lives. Can they also find ways in which the two places are alike? They are, for example, both a part of "The Land You Live On." Therefore, they both receive sunlight and are surrounded by air having the necessary properties for the growth of animals and plants. The illustrations show that each has soil in which plants can grow, and rock formations related to the surrounding surface features.

The appearance of the earth in a mountainous region is described on page 103. Even in the mountains where Bill lives there are differences in the earth. Ask the children if they can find the three types of mountains Bill can see near his home. (They are snow-capped, bare and rocky, and tree-covered.) Do the children know how the land near Bill's home is different in winter and summer? (Wild flowers and free-running streams can be seen near Bill's home in summer. The streams are frozen and the mountains are covered with deep snow in winter.)

Islands are still another part of the land on which people live. Page 104 shows an island where Ben lives. The surroundings near Ben's home are different from those in other locations mentioned thus far in the chapter. The chief difference is that Ben's home is completely surrounded by water. Develop with children the concept of what an island is. Encourage them to tell about any islands they know of or have visited. You might ask the children:

Has anyone in the class ever lived on an island?
Did it look like Ben's island?
Where was this island?
How did you get to the island?
What was all around the island?
Where else in this chapter was water pictured near someone's home? (Jean's home was shown by the ocean, and a mountain stream was pictured near Bill's home.)

The questions in the paragraphs dealing with the earth near Ben's home should stimulate further discussion among the children reading the text. Do the children now recognize water as part of the earth?

As children read about Jane's home on the plains they are introduced to another aspect of the appearance of the earth. Ask the children to notice how the section of the earth near Jane's home is different from that part of the earth that is near Ben's home. Also ask them to see how the grazing plains where Jane lives are different from the grain-growing plains shown on page 100.

Thus far in this chapter places some distance apart have been presented. One might expect places far apart to differ from each other in appearance. But in places close together also there are differences in the appearance of the earth. This idea is presented on page 105. Land forms and the type of vegetation, or the lack of it, may vary within a town, a village, on a farm, on a ranch, or from one side of a city to another. There may be differences in the landscape in even smaller areas such as in a field, on a hill, in a yard, or by a stream. As is indicated in *Science Everywhere,* there may be high places and low places, wet places and dry places, rocky, bare places, and areas covered with vegetation. How many of these differences can the children find in their home yards? In the schoolyard? In the block where they live? From one side of town to the other?

Many times when families go on trips about the earth, their goal is a park, forest reserve, or wilderness area. In these relatively unspoiled places one may see various land forms and living things in practically their natural state. Parks have been established where unique features

such as caves, glaciers, geysers, unusual rock formations, deep gorges, canyons, and spectacular desert scenery are of unusual interest. Some of these natural park areas are discussed on page 106 of *Science Everywhere.*

Pages 106–107 · Places to See on the Earth

Children may have had opportunities to visit parks and may wish to tell about their experiences in these areas. Parks usually mean different things to different children. To many city children, a park is a landscaped area within the city limits, usually containing benches, playground equipment, and sometimes a zoo. Other children think of amusement parks with rides and concessions. To some children, a forest reserve with a lake or stream and picnic tables is a park. The only parks other children may have seen are roadside parks along the main highways. Those children who live near government-supervised state, provincial, or national parks have still a different concept of a park. Encourage children to tell what they think of when they hear the word *park.*

The type of park referred to in this section of *Science Everywhere* is the government-supervised state, provincial, or national park, which is a region that has been preserved as nearly as possible in its natural condition. On page 107 of the textbook, glimpses of four such parks are pictured. The first is Glacier National Park, located in Montana on the border between the United States and Canada. It extends into Canada as the Waterton Lakes National Park. Together they constitute the Waterton-Glacier International Peace Park. This area is noted for its numerous active glaciers, glacial lakes, and rugged mountain scenery. The second illustration shows Old Faithful, a geyser in Yellowstone National Park, Wyoming. This region contains more geysers than are found in all the rest of the world. It is well known also for its hot springs and mud volcanoes.

The deep canyon shown in the third illustration (lower left) is the Grand Canyon of the Colorado River, a national park in Arizona. This deep gash in the earth's surface is the result of the eroding force of running water, the Colorado River. Through eons of time, this stream with its burden of silt, sand, and gravel has cut a canyon nearly one mile deep through the rocks of the high plateau region of northwestern Arizona. The great depth and extent of this canyon together with the brilliant colors of the rocks through which it is cut have made this area one of the most interesting places on the earth. Another interesting place on the earth is shown in the picture of Niagara Falls. These falls are located where water from Lake Erie flows into Lake Ontario. The falls

are divided by Goat Island. The larger falls are the Canadian Falls. The smaller falls are the American Falls. The United States and Canada have co-operated to preserve these beautiful waterfalls.

Of course, all these parks and natural wonders are parts of the earth. Note how different some of them are from each other and the variety of natural features they present.

The earth with space on it for all these falls, parks, deserts, forests, oceans, plains, and islands is indeed a very large place. Although distances on the earth may be traveled today in shorter times because of improved transportation, and although the telephone and radio have brought people into closer and more rapid communication, to most adults the earth still seems very large. It probably seems even larger to eight- and nine-year-olds.

Pages 108–109 · The Big Earth

The size of the earth is discussed on pages 108–109 of the textbook. As children look at the illustrations and read the text on these pages they may wish to tell some of their experiences in looking down at the earth from a high point. They may want to describe how they felt, and what they could see. The vantage points mentioned on page 108 are the top of a high hill and the top of a tall building. Can the children think of other places from which they can get a good view of the earth? They might say from a mountain top, from a high bridge, and from an airplane. Ask them what they could see from there; whether the things they could see would seem larger or smaller than when seen at close range; and whether they can tell why.

When things are far away they look smaller than they do when they are seen at close range. Have children test this statement by looking at such objects as a ball, a lunch box, or a chalk eraser close at hand and then from a distance. Suggest that they look at these things from across the room, from the other end of the hall, or from some distance away on the playground. Ask them to decide whether the ball looks larger when they hold it in their hands or when they see it from the other end of the hall, and whether the lunch box looks larger from across the room or from some distance on the playground.

Although each of these objects seems smaller when viewed from a distance, at least one side of each object can be seen. Larger objects, such as a ship, a building, an airplane, or a barn, also look smaller when they are seen from a distance. But still one side of each of these objects can be seen, unless other objects intervene. When you look at the earth, however, no matter how excellent your vantage point, only a very small part of it is visible at any one time from any one place. No one has

ever seen the whole earth, no matter how far away from the earth they may have been. No one has even seen one half of the earth at one time. The earth is much too big for that.

Then how do people know where they are going on the earth if they cannot see what is on the other side? How can people travel across a country, or over mountains, or across oceans if they cannot tell where they are going? Such questions as these may come to the minds of children as they learn about the great size of the earth. The answer, of course, is that they use a map or a globe. By studying a map, one can tell something about the way the earth looks in an area he has never seen. With a map one can tell where there is land; where there is water; the locations of rivers, lakes, and oceans; the locations of mountains, deserts, swamps, and islands; and the locations of cities, states, and other countries.

Pages 110–111 · Traveling on the Big Earth

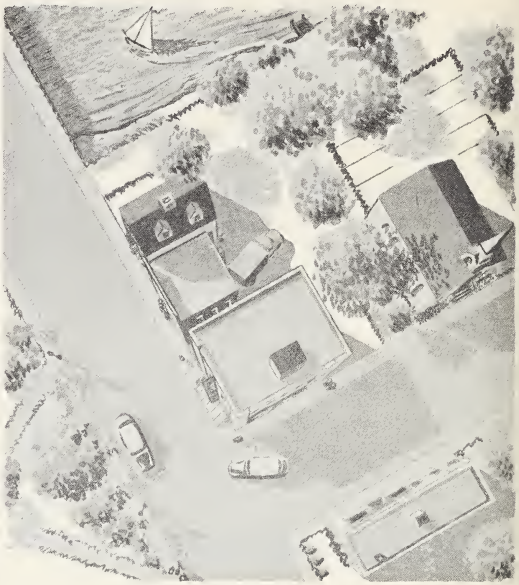
The questions on page 110 may be used to stimulate a discussion of "Traveling on the Big Earth." Note also the suggestion that a map be used to show a trip the children have taken. Maps are part of classroom equipment in many schools. If you do not have a map large enough to be displayed from the wall, some of the children may be able to bring road maps from home or obtain them from local gasoline service stations free of charge.

Sometimes it is difficult for children to see the relationship between places on a map and places on the earth. It may be helpful to explain that a map of an area is made as though one is looking down at that area from an airplane. Many maps are actually drawn from aerial photographs taken high above the earth. These photographs are pieced together and used as the basis for maps. A map might be placed on the floor to help children see the relationship between the map and actual places on the earth. It is from such a point of view, that is, looking down upon the earth, that some maps are made.

If one looks down on a town, for example, the parts of all objects one sees are just the tops: the roofs of buildings, the tops of automobiles, the surfaces of streets and roads, the rounded crowns of trees, the surfaces of bodies of water, the tops of people's heads. In the sketches on page 122 of this Manual, a scene is shown in two different perspectives. The first sketch shows the scene as it would appear to someone walking along on the surface of the earth, and the second shows how it would appear to someone looking down at it from a low-flying airplane.

If one could fly higher and higher above the earth, objects on the earth would appear smaller and smaller and finally merge with the

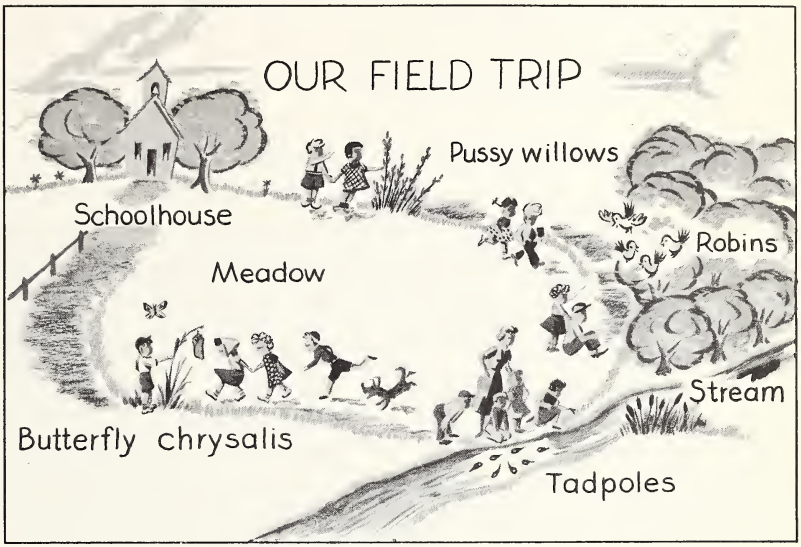
background of land forms. Highways would appear as lines drawn on a piece of paper; streams and rivers, as wavy ribbons; and fields and woodlands, like pieces of a patchwork quilt.



Another way to help children interpret maps is to have them make a simple one. This might be a group project. The subject for their map might be the school grounds, or the place where the class went on a field trip, or the safest way to go from school to the public library. Although the road maps and large classroom maps which the children have used are drawn to scale, no attempt should be made at this point to have children draw their maps to scale. But careful attention should be given to directions and the orientation of objects on the map. If the library is south of the school and faces west, it should be drawn in that position on the map. If a highway runs east and west past the school, the highway shown on the map also should run east and west. If a stream visited by the class on a field trip is north of the school and flows in a southeasterly direction, the stream should be so located on the map.

An example of a simple map which children might make is given on page 123 of this Manual. This is a map of a field trip taken by a class to a stream near the school to see tadpoles in their natural habitat. On the way, the class crossed a meadow and stopped to see some pussy-willow bushes. They walked along the edge of a woods, where they saw

a flock of robins settle in a tree. They stopped for some time at the stream. On the way back, they found a butterfly chrysalis on a last year's milkweed stalk. All these objects and incidents may be shown on a simple map.



On a wall map or maps in books, north is usually at the top, south at the bottom, east to the right, and west to the left. Among the exceptions to this plan for maps are those which center on the polar regions. As children use maps to show places they have traveled, be sure that they understand how directions are shown on a map. Watch for such errors in map interpreting as pointing in one direction and speaking of traveling in another.

As children point out their travels on a map, you might guide their presentation by asking:

When you started on your trip, which way did you go from your home?
In which direction were you going when you crossed the river?
Which way was the river flowing?
Was the park you visited north, south, east, or west of your home?
Which way does the highway run as it passes your town?

On page 111 of *Science Everywhere* a globe, which is another type of map, is introduced. The questions on this page will be useful in discussions. In addition, the following questions might be used to help children clarify their thinking about maps and globes and their relationship to the actual earth.

How is a globe like the earth?
How is it different from the earth?
How are a map and a globe alike?
How are they different?
What can you learn about the earth by using maps and globes?
Can you find some of the places on the globe that you found on the map?
Give an example.

Pages 112–114 · Learning More About the Earth

An extension of information about using a globe is given on pages 112, 113, and 114 of *Science Everywhere.* The globe used in the illustrations on these three pages is a large one. The activities carried on by the children described in the text, however, may be done by children in your class with a smaller globe. As the textbook states, a globe is like a little earth, or a miniature of the earth. It is useful because it is small enough to be handled, and because places on the earth can be seen in their relationship to each other.

As children experiment with a globe see if they understand the directions on it. Can they locate the Atlantic Ocean and the Pacific Ocean? What countries can they locate? Can they identify their own country? Can they find their home town on a globe? Many globes do not have the names of small towns on them, so the children may have to estimate where the dot representing their home town should be. If they wish to take an imaginary trip around the earth as suggested on page 113, suggest that they answer the questions on page 114 as they go on their "trip."

Page 115 · Some Things to Think About and Talk About

Page 115 is designed to help children summarize some of the science learnings developed in this chapter, and to help them become increasingly aware of the size of the earth and the great variety of surface features, vegetation types, and climates which go to make it up.

Materials and Equipment

Materials needed for experiences suggested by *Science Everywhere*:

globe
maps, wall, road, other

Materials needed for Further Experiences and Activities:

animals, small, representative of woodland, desert, and swamp
aquariums or large glass jars
box, shallow wooden
charcoal
ceramic or modeling clay

cold-water paints or crayons
drawing paper
food for animals
glass and screen tops for terrariums
gravel
leaf mold or rich garden soil
magnifying glass
newspaper
peat
plants representative of woodland, desert, and swamp
rock samples from local community
sand
soil samples from local community
soil to make mound in shallow box
sprinkler-type watering can or bulb plant syringe
wheat flour for papier-mâché paste

Additional Experiences and Activities

1. Learn about the rocks which make up part of the earth. Make a collection of rocks and stones found in your neighborhood. Suggest that the children collect them on the way to school from vacant lots, from pastures or plowed fields, or from an outcrop near your school. Have them notice how many different kinds of rocks are found. In some areas there may be little variety, in others more. Suggest that the small stones brought to the classroom be compared with larger rocks or boulders that show above the ground near the school.

Books listed in the Bibliography may help your children enjoy making rock collections and displays.

Madison Public Schools, Madison, Wisconsin

2. Look at some of the soils which make up the earth. Collect soil samples from various places nearby. Caution the children to take only

small amounts of soil and not to disturb growing plants or other environmental conditions. They may bring samples from their gardens, from a roadside or near a stream, or from the playground. Then ask them to look at their samples with a magnifying glass to find out if they all look alike. Can they see what the soil is made of? Can they see sand or bits of rock in some of the samples? Can they see bits of plant stems, leaves, or twigs in other samples? Ask them to notice how the garden soil is different from the soil found on the playground, for example, and how the soils differ in texture and in color. Ask the children to decide how many different kinds of soils were found where they live.

3. Show the process of erosion. In the illustrations on page 107 of *Science Everywhere* children may see the results of water erosion on a grand scale. They may see the same action on a smaller scale in the classroom. In a shallow box make a mound of soil. Then with a sprinkler-type watering can pour water over the mound. At first, tiny gullies will form where water runs down the mound. As more water is poured over the mound the gullies deepen. The faster the water is poured the faster gullies form and deepen. You can explain that this is the same thing that happens when canyons are formed, except that canyon cutting involves much more water and much, much more time.

4. Make a terrarium. It is often interesting and enlightening to reproduce portions of the outdoor environment in the classroom. This can be done by arranging terrariums of various types. They may be made in an aquarium tank, a large mayonnaise or pickle jar, a glass dish, or other similar container. Different types of regions on the earth may be duplicated in them. One terrarium might be made to represent a desert, another a meadow, another the bank of a stream, and still another a forest or woodland.

For a woodland terrarium, leaf mold or rich garden soil, gravel, and charcoal should be placed in the bottom of the container. The soil furnishes a medium in which the plants can grow. The gravel allows air to circulate through the soil, and the charcoal keeps the terrarium "sweet" by retarding bacterial action and the formation of molds.

When representing the bank of a stream or swampy area in a terrarium, the basic ingredients should include a third each of sand, gravel, and peat. Soil conditions in bogs and swamps are usually acid. The peat furnishes the necessary acidity for this type of terrarium.

In a desert terrarium, ordinary garden soil may be used. It is sometimes desirable to add a little sand.

To all three types of terrariums described here, plants may be added. Some of these plants might be obtained from the environment by the children. This is certainly the most desirable way to stock a terrarium. Chil-

Lawton School, San Francisco Public Schools, San Francisco, California

Preparing terrariums that reproduce different parts of the outdoor environment can lead to a better understanding of the variety in places on the earth.

dren whose parents have lawns and gardens will enjoy contributing plants from their homes or nearby fields for the terrariums. If your school is in a metropolitan area where this is not possible, some of the plants might be obtained from the grounds keeper at the school or a city park. If it is impossible to get appropriate plants from the immediate environment, they may be purchased from scientific supply houses. (See page 151.)

"After the plants have been introduced into the terrarium, it should be kept in a place where the temperature is not over 70° F. for about two weeks. This will give the plants an opportunity to establish a good root system. For the desert terrarium a screen top should be provided; the other types should have glass tops. The desert terrarium should be placed where it will receive considerable light, while the others should be placed in subdued light. If the terrarium is kept covered, it will need additional water only occasionally.

"To complete the terrarium, small animals may be added. Tree frogs, salamanders, and toads may be placed in the woodland terrarium; in the desert terrarium such animals as small snakes and horned toads will add to the effectiveness of the scene.

"Care must be taken not to use too much water in any terrarium. If there seems to be too much moisture, the glass top may be removed for

a time, permitting some of the excess to evaporate. Molds sometimes appear if there is too much moisture. They may be eliminated by the use of a little powdered sulfur or slaked lime. If aphids appear, the animals should be removed from the terrarium and the plants sprayed with a solution of nicotine sulfate, which may be purchased from any drugstore and used according to the directions furnished with it.

"Salamanders and turtles should be removed from the terrarium when they are to be fed. They will live on small earthworms, swatted flies, raw fish, or small pieces of raw meat which has been finely ground. Toads will eat live flies placed in the terrarium; horned toads and other lizards must have living food. They will eat meal worms, cockroaches, grasshoppers, and ants. Small snakes will eat cockroaches, earthworms, and small fish." [1]

5. Make maps. Draw a map of a make-believe country. Include on it: the four main directions; a river, lake, and ocean; mountains; an island; and any other features the children wish. Show with a marked trail a trip that might be made through this make-believe country.

6. Write stories. Suggest that the children write a story about their map of a make-believe country. Or they might write a story about a real trip they have taken in which they tell about the different geographic features of the earth's surface they saw. Another story topic might be an imaginary trip made by using a globe or a map.

7. Make pictures or models. Suggest that the children draw pictures to show some of the earth's surface features, such as mountains, canyons, islands, dunes, plains, beaches, deserts, and geysers. These features may also be shown in three-dimensional models made of papier-mâché, ceramic clay, or nonhardening oil-base modeling clay. The ceramic clay and papier-mâché finished models may be painted with water-soluble paints.

Evaluation

In evaluating the results of the children's experiences in connection with this chapter you will wish to determine just how a child's concepts of the earth he lives on have developed and enlarged. What concepts did each child have concerning the earth when he began to work with this chapter of *Science Everywhere*? Has he gained any new ideas about the earth? Has he changed any of his opinions about the earth as he gained new information? Do such words as mountain, desert, ocean, geyser, canyon, plains, forest, direction, map, and globe, for example,

[1]Gerald S. Craig, *Science for the Elementary-School Teacher*, New Edition, p. 496. Ginn and Company, 1958.

have more meaning for him now? Has he developed a better understanding of the great size of the earth? Does he show an interest in helping to preserve and maintain some of the beautiful places on the earth that have been set aside as parks? Does he understand why such areas are protected by rules and regulations? Is he more aware of the many differences in the appearance of the earth's surface in various locations? Can he see some of the relationships between the different surface features and the plant and animal life found in each? For example does he understand how it happens that spiny plants and animals that can go without water for long periods are found in desert regions? Ascertaining the answers to questions such as these should help you measure the effectiveness of the experiences provided.

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DESERTS. (Gateway) b/w. Shows how deserts are made, the plants that grow on certain deserts, and the effect of irrigation.

GEOGRAPHY OF YOUR COMMUNITY. (Cor) b/w and color. Illustrates how a boy learns about the geography, industries, rivers, highways, residential sections, and other phases of his own community.

WHAT MAKES A DESERT? (YAF) b/w. Explains in simple terms the factors that make a desert.

Filmstrips

A WALK IN THE WOODS. (CurrF) color.

CHANGING SURFACE OF THE EARTH. (YAF) color.

THE DESERT. (CurrF) color.

LIFE IN DESERT LANDS. (PSP) b/w.

LOW TIDE AT THE BEACH. (CurrF) color.

STORY OF MOUNTAINS. (EBF) color.

IX

The Sky Above You

From an early age, many children evidence an interest in the sky. Among their early childhood poems are "Twinkle, twinkle, little star . . . ," and "Starlight, star bright, first star I see tonight . . . " They may later learn to recognize the Big Dipper, the Little Dipper, and sometimes the North Star. They may have heard legends about the sun, the moon, the Milky Way, and other stars. They may also have heard superstitions about the effect heavenly bodies have upon the earth and the people living here. They may be familiar with such sayings as "The moon is made of green cheese"; "There is a man in the moon"; "If you wish on a falling star, your wish will come true"; "You can tell your fortune by the stars."

It is the purpose of this chapter to capitalize on this natural interest of children in presenting information which will help them understand the sky above them. In particular, this chapter deals with: the sun—its size, brightness, heat, distance from the earth, and its importance to life on the earth; the moon—its size in comparison with the earth and the sun, what the moon is thought to be like, how the moon is different from the earth and how the two are similar, and what moonlight is; and the stars—the ways stars differ, their great number, and the difference between their brightness and that of sunlight and moonlight.

No attempt has been made in this chapter of *Science Everywhere* to present the various sizes of heavenly bodies or their distances from the earth in actual figures. Figures needed to describe interstellar and interplanetary space are so large that they would have no meaning for children of this age. Indeed they have little meaning even for many adults. Therefore in the textbook sizes and distances are compared with concrete objects and distances commonly known to children.

Science Meanings to Be Developed

Children need help in interpreting the things which they observe in the sky, and the effects of the sun, moon, and stars

upon the earth. As they read about "The Sky Above You" it is hoped they will develop some understanding of the relationships which exist between the sun, moon, and earth. Some of the science meanings which should become familiar by studying this chapter are:

The sun, moon, stars, and clouds are objects in the sky.
Sunlight is the brightest light we know.
The sun is the largest object in the day sky.
Large objects seem small when seen from a distance.
The sun is too far away from the earth for anyone to go there.
Scientists have spent many years learning more about the sun.
The sun is made of hot, glowing gases.
Some of the sun's heat and light reach the earth.
The light and heat from the sun are necessary to life on the earth.
There are colors in a beam of sunlight.
When the rays of light in a sunbeam are scattered, these colors can be seen.
The moon is smaller than the earth or the sun.
The moon is nearer the earth than any other object in the sky.
The moon is solid like the earth.
Light from the sun reaches the moon.
The moon and the earth are alike in some ways and different in other ways.
Moonlight is never as bright nor as warm as sunlight.
Moonlight is light from the sun reflected by the moon.
Stars vary in size, brightness, and distance from the earth.
Starlight is not as bright as moonlight.

Information for the Teacher

Children are so far removed from objects in the sky that it is difficult for them to gain concrete ideas about them. They have no way of examining the sky bodies at close range as they would examine a rock, a tree, or an animal. The great distances from which children must be content to view the sun, moon, and stars may well cause confusion in their thinking as they formulate ideas about objects in the sky. This is particularly true when children are developing ideas concerning the sizes of objects in the universe.

Children are on the earth, so the earth seems very big to them. It is only natural that many youngsters come to the conclusion that the earth is, in fact, bigger than anything else in the universe—bigger than the sun, the moon, and the stars. Of course this conclusion is erroneous, but it may seem valid to a child. He may think of the sky as a dome over

the earth, a canopy, or a covering with a definite top to it. One small child asked the question, "If I stood on a chair could I reach the sky?" Other children have asked, "How high is the sky?" "Where does the sky end?" These questions represent children's attempts to find out something about the vast universe, of which the earth is a tiny part. Since children have little or no way to interpret correctly the things they see in the universe on their own, it is the responsibility of educators to help them obtain reliable information. Teachers may help by becoming familiar with source material such as is presented in *Science for the Elementary-School Teacher*, by Gerald S. Craig. They may also place scientifically accurate books in the hands of their pupils. They may secure information from authorities and specialists in the field of astronomy.

The sun is probably the most familiar object in the sky to children. It provides the light they know as daylight. It makes the day sky different from the night sky. When the sun is shining, children are occupied with their work and play. When the sun disappears from the sky with the approach of night, it is usually time for children to come indoors and prepare for bed.

The sun, while important to us as a source of light and heat for the earth, is only one of many suns in the sky. There are countless other suns in the universe, many larger than our sun. The sun which lights our earth is in reality a star. It shines with its own light. It is nearer to us than any other star in the universe, being about 93,000,000 miles distant. The next nearest star is 25 trillion miles away from the earth.

Our sun seems brightest to us because it is so near the earth. There are other suns much larger and much brighter than ours, but their light seems dim by comparison because they are so far, far away. The sun is composed of gases which are so hot that they glow, or are incandescent. The sun glows as does the element in a light bulb or an electric toaster. It does not burn as fire burns. Heat and light go out from the hot, glowing sun in all directions. Some of the light and heat from the sun reaches the earth. This portion of the sun's energy is small, but this small amount is important to us. It makes life, as we know it, possible on the earth. Without this small part of the sun's light and heat, the earth would be a dark, cold, lifeless sphere.

Around the sun and held near it by the sun's gravity are nine planets of which the earth is one. Some of these planets have moons. The sun and its planets with their moons make up the solar system. You are urged to find out something about the other planets and moons in our solar system. Helpful source material on this subject may be found in Gerald S. Craig's *Science for the Elementary-School Teacher*, New Edition, pages 189 to 226.

The moon which revolves around the earth is the heavenly body nearest to us. The moon, unlike the sun, is composed of solid elements. It is many, many times smaller than either the sun or the earth. It is also much nearer the earth than the sun. The distance from the earth to the moon varies from 222,000 to 253,000 miles. The moon gets its light from the sun. Like the earth, the moon has no light of its own. Moonlight is really sunlight which is reflected from the surface of the moon to the earth. The moon, like the earth, has mountains on it. Some of the mountains on the moon have been estimated by scientists to be between 20,000 and 25,000 feet high. Since the moon is such a small heavenly body, some scientists think that there is not enough gravity to hold an atmosphere about it. Without an atmosphere and the accompanying moisture, life as we know it could not exist on the moon. The days would be exceedingly hot and the nights very, very cold without an atmosphere to temper the sun's rays during the day, and retain some of the sun's heat during the night.

Stars are a source of interest to many children. They often enjoy watching them on clear nights, or trying to count them, or speculating about what they are like. About four thousand stars are visible to the unaided eye, and only half of these are visible at any one time. Some stars can be seen only with the aid of a powerful telescope. There are many, many more which we cannot see even with a telescope because they are so far away.

While clouds are not heavenly bodies, they must still be considered in any discussion of what is in the sky. Clouds are relatively near the earth. They occur in approximately the first 10 miles of the earth's atmosphere. This distance from the earth is small compared with the hundreds of thousands of miles which characterize the distances from the earth to other objects in the sky.

Ways of Working with Children

You may wish to introduce "The Sky Above You" on a bright sunny day after a period of rainy weather when the children are enjoying playing outdoors in the light and warmth of the sun. Or you may plan to start during a week when the moon can be seen in the morning sky when a discussion of this phenomenon might lead to an interest in learning more about sky bodies. Or reading about the sky might follow discussion among the children of a recent record set by aircraft at a new elevation. Everyday events and observations offer children many incentives to learn more about the sky.

Pages 117–119 · What Is in the Sky?

On pages 117–119 of *Science Everywhere* children are encouraged to recall what they know about the sky. They are asked to look at the sky and tell what they can see. Both the day sky and the night sky are discussed. As children read these pages have them observe the sky and talk about what they see. The discussion might be guided by such questions as:

How does the sky look today?
What can you see in the sky today?
Why should we not look directly at the sun?
Why does the sky look darker on a cloudy day than on a clear day?
What is the brightest light we see in the sky?

Pages 120–123 · The Big Bright Sun

On page 120, the size of the sun is compared with the sizes of things on the earth. Children may think that the sun is really very small, since it appears small to them because of its great distance from the earth. The sun may be hidden by a building, a tree, or an automobile, and for this reason children may conclude that it is smaller than these objects. In reality, the sun is larger than either the moon or the earth. It may be hidden temporarily by smaller objects because they are near and the sun is far away. At this point it might be worth while to review the experiments suggested on page 120 of the Manual concerning the appearance of objects of various sizes at varying distances.

The sun is about 93,000,000 miles away. This is a distance too great for most individuals to comprehend. For this reason, the distance has been expressed on page 121 of the textbook in terms more easily understood by children. The two hundred years mentioned may be more meaningful if it is related to events about which children know. For instance, the sun is so far away that if, when he was twenty-two years old, George Washington had started for the sun on the same fast train as shown, he would have arrived there in 1954. Then it would take him two hundred more years to return to the earth. Or, expressed in another way, it would take just a little less time for a trip to the sun and back than has elapsed since Columbus discovered America in 1492.

Children are exposed to many stories and radio and television programs dealing with space travel. Paragraph 2 on page 121 of *Science Everywhere* gives children an opportunity to speculate about an imaginary space trip. They may wish to write stories about a trip to the sun, moon, or other object in outer space. As they write they may begin to realize the limitations such a trip would impose, and how earth-bound

we really are. The awareness of such great distances will help children appreciate the vastness of the space in the universe.

Although no one has ever been to the sun, scientists have studied it through telescopes for many years. From their studies, we have learned some of the sun's characteristics. On page 122, certain of these characteristics are described. What do your children think the sun is like? Allow them time and freedom to speculate without fear of censure for having incorrect information. Both facts and misconceptions are likely to be revealed in a free discussion. Teachers may use the information gained in such discussions as signs indicating the direction which further classroom instruction should take.

As children speculate about the sun try to determine the reasons for their statements by such questions as: Why do you say that? Have you ever heard that before? Why do you think so?

Children may indicate their awareness of the fact that the sun makes the earth light and warm by such statements as: "I know the sun is hot because I got sunburned last summer"; "Sometimes it's so hot you just want to get under the hose"; "When I came out of the movies, the sun was so bright it hurt my eyes and I couldn't see for awhile"; "The sun was so bright on the snow that my sister was snow-blind when she was skiing." Such statements show an understanding from firsthand experiences of at least two of the sun's characteristics.

The idea that the sun glows but is not on fire may be a new one to children. To many children of this age, heat usually means a fire. It should be pointed out that heat may come from a source which is glowing but not on fire, such as the glow from an electric heater. Have them list as many heat sources as possible which glow but which do not burn with a flame. A few such sources are: an electric toaster, the element in an incandescent light bulb, the heating unit of an electric stove, and the embers of a charcoal fire.

The sun does not shine just to furnish light and heat to the earth. The earth is not the only recipient of light from "our" sun. Heat and light go out from the sun in all directions. That portion which reaches the earth is only a tiny part of the sun's total light and heat. But that tiny amount is very important to us. Life on the earth could not exist without it. The importance of sunlight to living things is described on page 123 of *Science Everywhere.*

You might help children notice evidences of the effects of the sun on growing things by asking:

What happens to plants when they receive sunlight from one side and are shaded on the other? (Stems bend and leaves turn toward the side which is illuminated.)

What happens to the appearance of people who remain indoors and out of sunlight for some time? (They usually appear pale and often lack vitality.)

How do plants in a dark place where they receive no sunlight appear? (Stems are usually pale or nearly white, and leaves are limp and lacking in color.)

The first activity suggested under "Additional Experiences and Activities" indicates the importance of sunlight to growing plants.

Pages 124–125 · Sunlight and Color

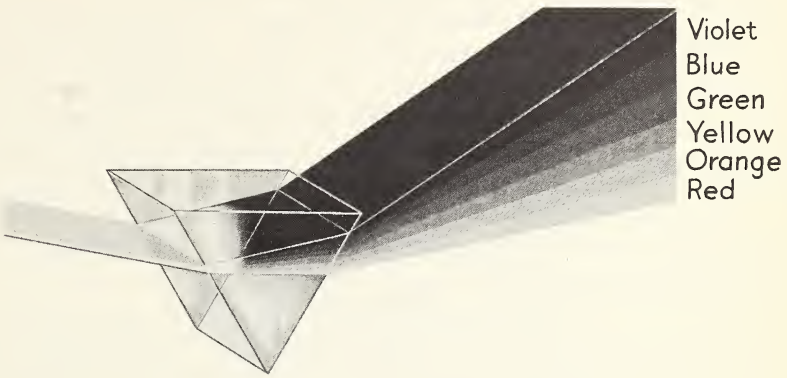
Pages 124–125 of *Science Everywhere* deal with sunlight and color. There is no visual sense of color without light. Children may experience this fact by closing their eyes, or by going into a darkened room or closet and answering the question, "What color can you see in the dark or when your eyes are closed?" This same phenomenon may be experienced as the light from the sun becomes less and less with the approach of night. A tree which looks green in full sunlight seems to lose its color as the sunlight disappears. In twilight the same tree appears as a black silhouette. Do the children think the green really fades from the tree as the light becomes dimmer? If they do, suggest that they pick a leaf from the tree after dark and take it into the house where there are bright lights. They will see that the leaf appears green again.

As children discuss the questions asked on page 124 probably only a few will have the information that sunlight is not a single color, but is composed of many colors. The colors in a beam of sunlight are called the spectrum. They are not visible unless the light can be scattered or separated into its various colors. Page 125 deals with ways to scatter rays of sunlight so that the spectrum colors are visible. The spectrum colors always appear in the same order, namely, red, orange, yellow, green, blue, and violet, with each color blending into the next in a rainbow effect.

The diagram on page 137 shows a beam of sunlight passing through a triangular piece of glass called a prism. It shows the order in which the spectrum colors appear. As the light passes through a prism the rays are bent and reflected so that each color can be seen. The red rays are bent the least and the violet rays are bent the most.

Water, too, often acts as a prism to bend and reflect light so that the different colors are visible. When this happens a rainbow is formed. The illustration on page 125 in the textbook shows how water in an aquarium tank bends and scatters rays of sunlight so that the spectrum colors can be seen. The prism shown with the third paragraph obtains the same result. If it is possible to secure a prism, it would be worth

while to have the children try the experiment that Susan is shown doing at the bottom of the page. If a glass prism is not available, an aquarium tank properly placed in relation to the sunlight will show the spectrum. A beveled mirror, cut-glass bowl, or piece of crystal jewelry also acts as a prism to bend and reflect light to reveal a rainbow of colors.



A beam of sunlight striking a prism emerges as a color spectrum.

Pages 126–128 · The Moon and the Earth

The moon is the earth's nearest neighbor in the sky. Its average distance from the earth is about 240,000 miles. Knowing that this is ten times the distance around the earth at the equator may help children to comprehend this figure. No doubt many children have watched the moon, speculated about what it is like, and perhaps daydreamed of traveling there in a space ship. So far no one has ever been to the moon, but scientists have observed it and from their observations have gained ideas of what the moon is like. The information given in the textbook and the Manual describing the appearance and some of the characteristics of the moon has been ascertained from such scientific observations.

A portion of the moon's surface is shown in the illustration on page 126. Encourage the children to talk about the picture. Are they surprised at the moon's appearance? Is this picture in any way like their idea of the moon? What features of the moon's surface seem to impress them the most?

Have children compare the moon mountains and earth mountains in the illustrations on page 127 of *Science Everywhere*. The questions on that page should help to guide their thinking.

On page 128 the ways in which the moon differs from the earth are described. See how many differences the children can find as they read this page. The differences given are: the moon is smaller than the

earth; it is too hot by day and too cold by night for people to exist there; it is thought to have no atmosphere, hence no clouds, fog, rain, or other weather phenomena associated with an atmosphere; there seems to be no water on the moon; there are no plants and animals such as we know.

Pages 129–130 · How the Moon Shines

The idea of reflected light is probably new to many children eight and nine years of age. Before attempting to read pages 129–130 telling how the moon shines, it would be advisable to experiment with reflected light. On page 139 of this Manual activities which children may carry on to help them better understand this are described in Item 3 of "Additional Experiences and Activities." The diagram on page 129 of *Science Everywhere* will further help children to visualize how light from the sun is reflected from the moon to the earth as moonlight.

Page 131 · Watching the Stars

In some localities it is possible to see many stars because of the clarity of the atmosphere. If there is an opportunity, have children observe the stars in the night sky before they read page 131. Suggest that they look for the answers to such questions as:

How many stars can you see?
Do you recognize any star groups (constellations)?
How do some of the stars differ from each other?
How is the starlight you see different from moonlight or sunlight?

Page 132 · A Game for You

Answers to the questions asked in "A Game for You" are:

1. the sun
2. a star, or the stars
3. the moon
4. the sun
5. the moon
6. clouds

Materials and Equipment

Materials needed for experiences suggested by *Science Everywhere:*

crayons or water paints
mirrors, various sizes and shapes, or tin can strips or other shiny objects
paper, colored construction
pocket mirror
prism
thermometers, 2

Materials needed for Additional Experiences and Activities:

board, small, or piece of plywood
mirror or other shiny reflecting surface
paper, colored construction

Additional Experiences and Activities

1. Demonstrate that plants need sunlight in order to live. In a portion of the schoolyard where the lawn is well established, place a small board over a section of the grass. After several days look at the grass under the board. Note the changes which have taken place since the grass has been shaded from the sunlight. During the remainder of the time that the board is left on the grass, ask the children to find out:

a. How the grass changes in color
b. How it changes in its vigor of growth
c. What would probably happen if the board covered the grass for very long

When the grass is quite pale and colorless, remove the board so that the patch of lawn again receives sunlight. Continue to note the changes which occur when the grass again receives sunlight.

2. Demonstrate the relation between light and color. Look at a brightly colored piece of paper or cloth in normal classroom light. Then have a child take the colored paper or cloth into a closet or darkened portion of the room. Have him observe the color as he slowly closes the closet door or shuts out the light. Ask him what seems to happen to the color as the door is closed. What does he find the color looks like when the door is completely closed and the closet is quite dark?

Now have the child slowly open the door and admit light a little at a time. See if he can describe the reappearance of the color as the light increases.

3. Show how light may be reflected. A mirror is probably the reflecting surface best known to young children. Suggest that one child hold a mirror in a beam of sunlight and try to reflect a spot of light on a wall, the sidewalk, or the side of a building. Other children might try the same experiment with small mirrors, tin-can strips, or other shiny objects. Light may be reflected also from glass windows, car windshields, and the shiny surfaces of fenders, or metal roofs.

If a mirror is not available in the classroom, the shiny bottom of a tin can may be used as the larger reflecting surface with which to experiment.

4. Discuss legends about the stars. There are many interesting legends about the stars. Children may enjoy reading or hearing about some of the mythology connected with the better known constellations, such as the Big Dipper, the Little Dipper, Orion, the Seven Sisters, and Andromeda.

Evaluation

The game on page 132 of *Science Everywhere* may be used as a partial evaluation of the ideas gained by children about the sky and objects in the universe.

Oral reports about the sun, the moon, and the stars may be given by committees or individual members of the class. Children are not expected to memorize long lists of facts about these objects, but they should have retained some essential information about the sky corresponding to the science meanings outlined in this chapter. Oral reporting by the children usually serves as a means of summarizing what they have learned.

Checking to see how thoroughly and carefully children have read is sometimes a desirable way to evaluate factual learning. Such completion sentences as the following might be used:

1. (SUNLIGHT) is the brightest light we know.
2. We are in the shadow of (CLOUDS) on a cloudy day.
3. Large things look much (SMALLER) when they are far away.
4. Scientists tell us that the sun is made of (GASES).
5. We could not live without the light and heat from the (SUN).
6. There are many (COLORS) in a beam of sunlight.
7. The (MOON) is our nearest neighbor in the sky.

Changes in attitudes and behavior are indications of learnings which have taken place. You may be able to ascertain such changes by determining the answers to these questions: Have children relinquished their superstitions about the effects of the stars on their lives? Do they show by their questions and contributions that they understand the effects of sunlight on plants and animals? Are they gaining an appreciation of the vastness of space as a result of a better understanding of the relationship of the earth to other objects in the sky? Are they developing an appreciation of the importance of science and the work of scientists in their everyday living? Are they applying the learnings they have acquired to the solution of problems in new situations? All of these items are clues to the amount of real learning which has gone on as this topic has been studied.

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LIGHT AND HEAT. (Gateway) b/w. Illustrates sources of light, and what heat and light do for us.
LIGHT AND SHADOW. (YAF) b/w. An introduction to the nature and behavior of light.
THE SUN'S FAMILY. (YAF) b/w. Explains that the sun is one of the smaller stars, and that the nine planets, including the earth, revolving around it constitute its family.
THIS IS THE MOON. (YAF) b/w. Describes the physical characteristics of the moon, its relation to the sun and the earth, and its phases.

Filmstrips

LIGHT. (YAF) color.
THE SOLAR SYSTEM. (YAF) color.
STARS IN THE SKY. (EyeGate) color.

X

Using Water Wisely

Water is probably one of our most vital natural resources. It is one of the most abundant substances on the earth and one of the most important to us. We use water every day for drinking and washing. It is used by plants and animals alike; it is necessary to life.
In many places, water is so abundant that it is taken for granted. In other localities, securing an adequate water supply constitutes a real problem. Water is a resource which should not be wasted. Its wise utilization should be the concern of everyone, children and adults alike.

Science Meanings to Be Developed

The purposes of this chapter are to help children understand the importance of water to living things; to present some of the many ways water is used; to help children become aware of the importance of keeping streams, lakes, rivers, and other potential water sources free of debris and contamination; and to help them see the vital need for using water as well as other natural resources wisely.

In presenting the information in this chapter, the following meanings for children are developed:

Water is important to living things.
People store water for their use.
Water is stored in different ways.
Water is used in many ways other than for drinking.
Water is abundant in some places.
Rain is an important source of water.
Water is scarce in some places on the earth.
Crops must sometimes be irrigated with water brought from great distances.
Summertime is a dry time in some places.
Deep wells sometimes furnish needed water.
Water which is polluted or contaminated becomes useless to plants and animals.
Carelessness and indifferent behavior can waste our natural resources.
When used wisely, water as well as other natural resources provides pleasure and beauty.
Plants need water in order to grow.

Animals need water in order to live.
We enjoy water in many ways.
If there is to be enough water for everyone, we must use it wisely.

Information for the Teacher

Nearly three fourths of the earth's surface is covered with water. Most of the water of the earth is contained in oceans and seas. Since this water is salty, it is unfit for domestic use or irrigation. Therefore the water used by most plants and animals must come from another source, namely, condensation from the atmosphere. Water from the atmosphere may be precipitated in the form of rain, snow, hail, sleet, and dew. The chapter "Changes All About You" of *Science Everywhere* discusses the movement of water in and out of the air in connection with the evaporation of water from a birdbath. On pages 93–95 evaporation and condensation are described again in more detail. The text and illustration on page 96 show the water cycle. It will be helpful to refer to these sections as you develop the chapter "Using Water Wisely."

Water for our daily needs comes from the air in some type of precipitation, principally from rain and melting snow. City water supplies usually come from lakes, rivers, and streams. People on farms, ranches, and other areas beyond the reach of a municipal water supply get their water from wells and springs.

Nearly all water must be purified in some way before it is used for drinking. There is very little really pure water. Distilled water comes the nearest to being pure. Fortunately for us, water may contain many impurities and yet be safe for drinking. However, any water that is to be used for drinking should be tested to make sure that the impurities it contains are not harmful organisms. City water supplies are constantly checked and tested for harmful bacteria. These water supplies are filtered and the sediment removed before the water is piped into homes and other buildings. In some cities small amounts of chlorine are added to the city water supply as an additional precaution against any remaining bacteria that might be harmful to human beings.

Individual water supply systems, such as those found in suburbs and on farms and ranches, are often inspected by regional health departments to assure the consumer of safe drinking water. Sometimes the construction and location of wells are specified by a health department to make certain that disease germs and bacteria cannot seep into them. The danger of well water being contaminated is greater where there are barns, cattle sheds, and other outbuildings in the vicinity of the water supply. Drinking water obtained from such individual supply systems

can be made safe by boiling during periods of temporary contamination until the source of contamination can be removed.

Some streams, rivers, and lakes cannot be used as sources of drinking water because they are contaminated by trash, garbage, industrial waste, and human or animal excrement. The organisms causing such diseases as cholera, dysentery, and typhoid fever are likely to be found in water contaminated with animal wastes. It is in the individual's as well as the public's interest to see that streams, lakes, rivers, and other potential sources of drinking water are kept free of such organisms.

Next in importance to water for human needs comes water for livestock and irrigation. In some localities there is insufficient rainfall to fill lakes or to keep streams flowing. Nor is there enough rain to soak into the ground and build up an underground water supply which might be tapped with wells. In such areas, water must be brought from distant places, often at great expense. Frequently storage lakes are constructed in the mountains where there is considerable water from melting snow. Water for irrigation purposes is then piped from these lakes to farms, ranches, and homes miles distant. Many thousands of acres of once useless desert land have become productive under irrigation.

Water also has scenic and recreational value. Many resorts and recreation areas are located near lakes, rivers, bays, and oceans. Others are near waterfalls and tumbling mountain streams. Fishing, boating, swimming, and other water sports are popular today. Anglers eagerly await the opening day of the fishing season each year. Families plan their vacations to include a week or so at the beaches. Camera enthusiasts expose hundreds of negatives each year to capture the spray of waterfalls and cascades. Water certainly makes the earth on which we live more beautiful. It is important to make sure that recreational water supplies are utilized wisely and that scenic places are preserved so that they can be enjoyed for many years to come.

Ways of Working with Children

Children often take the presence of water for granted. One dramatic way to illustrate the importance of water to living things might be to bring into the classroom a wilting potted plant and then to watch what happens after it is watered. Another way of calling attention to our need for water would be to ask each of the children to keep an account of the number of times he drinks water during one day. Or the children might be asked to list all the ways they can think of that water is useful to them. Then they might turn to *Science Everywhere* to find out if it tells of other ways water is used.

Page 135 · Living Things Need Water

On page 135 of *Science Everywhere* the many needs for water are called to the children's attention. In connection with the information given about plants and animals needing water, you might ask:

How often do you give water to your pet?
How often does father water the livestock?
How often does mother water the house plants or the lawn?
How often does father irrigate the garden or his field crops?

As children become aware of the many times water is used every day they will be better able to understand the importance of water to living things.

Pages 136–137 · Storing Water to Use

Water is not always available just when it is needed in the form of rain or snow. It must, therefore, be stored during times of abundance for use throughout the year. Pages 136–137 describe three ways in which water is stored, namely, in water tanks, in lakes, and in stock or farm ponds. Ask the children: Is water where you live stored in any of these ways? Is the water you use stored in any other way?

Page 138 · Ways to Use Water

Four uses of water are given on page 138 of *Science Everywhere*. Of course there are many more. Those described, however, should suggest other uses. To help the children recall some of these, you might ask: In what other ways do you use water? (Examples are: bathing, laundering, household cleaning.) How does the community where you live use water? (Examples are: in swimming pools, for fountains in the parks.)

Pages 139–141 · Water in Sally's Town

In the sections of this chapter on pages 139–147 the amounts of water available in three different localities are described. Pages 139–141 describe Sally's town, a location of abundant water. The annual rainfall there is about one hundred inches. You can help the children to understand what it is like to live where there is this amount of rainfall by asking: If you lived in a place like Sally's—

How would the grass, trees, and flowers look?
How would the air feel? (It would be moist or damp.)
What would make the air feel this way? (There would be water in it.)
Would you wear rain clothes often?
Would you have to play indoors many days because of rain?

One hundred inches of rain is a lot of water. The activity on page 140 should be carried out with your children to help them better understand how much one hundred inches is. The question "What happens to rain when it falls to earth?" is answered on page 141 in connection with Sally's town. The same information is true, however, no matter where rain falls.

Pages 142–143 · Water on Paul's Farm

Irrigation farming is described in the section "Water on Paul's Farm." The area described here is in contrast to Sally's town. On Paul's farm there is not enough rain to grow crops. Drinking water is used carefully, since the supply is limited.

Rain and snow, however, fall frequently in the mountains near Paul's home. This water is stored in mountain lakes and reservoirs and piped down to Paul's farm and others like it in the valley. This rain water and melted snow provide irrigation water for the crops in the valley. Have children discuss any irrigation methods that are used where they live by answering:

How are the methods like those on Paul's farm?
How are the methods different?
How are Paul's farm and Sally's town different in appearance?
What makes them look different?

The picture on page 143 shows the contrast between an irrigated and an unirrigated portion of land in a very dry region. Have the children discuss this contrast in appearance by using the questions on page 143.

Pages 144–147 · Water at the Ranch

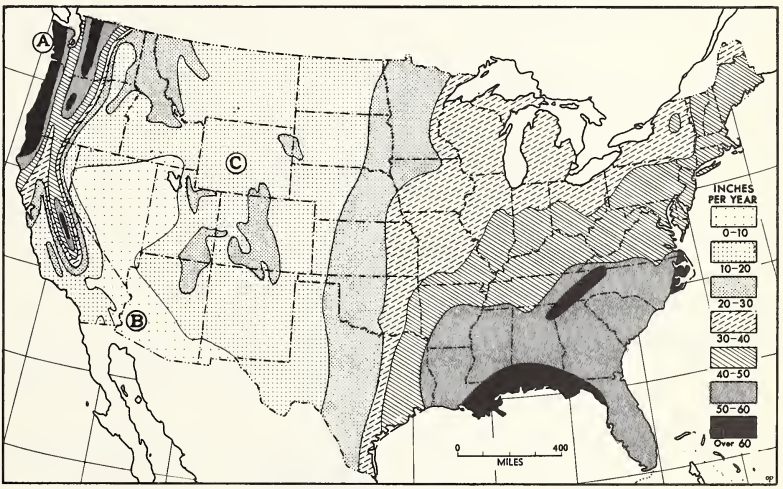
The third location discussed in this chapter is Joe's ranch, where the annual rainfall is just a little over twelve inches. The summers are usually dry. There is not enough rainfall to support lush vegetation such as was described in Sally's town. There are few trees on Joe's ranch. The main vegetation consists of grasses on which cattle feed.

Wells as a source of water are introduced on page 146. When natural water holes or rain ponds dry up, water must come from another source. This source is often wells. Windmills and stock tanks are familiar sights to any youngster who has lived in an area similar to the one where Joe's ranch is located. Some ranchers have a regular "windmill circuit" that they travel to connect the pumps so that the tanks will fill with water. Later they travel the same "circuit" to disconnect the pumps when the tanks are filled. The well and pump which furnish Joe's family with its domestic water are shown on page 147 of *Science Everywhere*.

Pages 148–149 · Water Where Ann Lives

In two sections of this chapter streams running through two towns are described. In the first town, where Ann lives, a stream has been polluted by trash, garbage, and industrial waste.

Have children discuss the questions on page 148 as they read and look at the illustration. Streams do not just happen to be the way this one is in Ann's town. Carelessness and indifference on the part of people living nearby are the real causes for a defiled stream. This idea is emphasized on page 149. You will also want to discuss the questions on this page with your children.



On this rainfall map is indicated (A) a region of the United States in which Sally's town might be; (B) a region similar to Paul's farm; and (C) a region in which Joe's ranch might be located.

Pages 150–152 · Clear Creek

In the second town, a well-cared-for stream is shown. Children may wish to compare the picture of the stream on pages 148–149 with the illustration of Clear Creek on page 151. The following questions may guide their discussion:

How is the stream in Ann's town different from Clear Creek?

How could the people in Ann's town make their stream like Clear Creek again?

How do you suppose the people near Clear Creek enjoy their stream in summer? in winter?

There are many scenic and recreational benefits to be derived from lakes, streams, and rivers when they are well cared for and used wisely.

Page 153 · Water for Plants — Page 154 · Water for Animals

The importance of water to plants and animals is emphasized on pages 153–154.

Pages 155–156 · Water for Everyone

The importance of water to human beings is described on pages 155–156 in both text and illustrations. See how many other ways of using and enjoying water your children can list. Again at the end of page 156 *wise utilization* of our water resources is emphasized. This point cannot be stressed too much!

Materials and Equipment

Materials needed for experiences suggested by *Science Everywhere*:

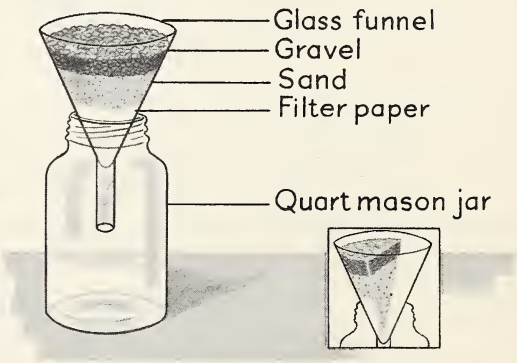
crayons or water paints
paper for pictures
yardstick

Materials needed for Additional Experiences and Activities:

filter paper (available at drug stores)
funnel, glass
glass jar, 1-quart
gravel
muddy water
sand

Additional Experiences

1. Water is filtered and purified as it passes through sand and gravel. Construct a simple filter such as the one shown below. Pour part



of the muddy water through the filter, and compare the filtered water with the remaining muddy water. Examine the filter paper to learn what it removed from the muddy water. Usually mud, sediment, small stones, and other matter will be filtered out.

2. If possible, take a trip to the water purification and filtration plant in the community where you live. Find out what happens to the water as it passes through this plant. Learn how the water which is piped to homes is different than when it entered the purification plant.

Evaluation

The activities listed on page 157 of *Science Everywhere* may well be used to evaluate the learning which has taken place as children have worked with this chapter.

Also the following questions may help you to further evaluate the effectiveness of your teaching.

1. Are children becoming more aware of the necessity of water in their daily lives?

2. Do they show a desire to conserve water by such spontaneous remarks as: "Don't leave the water running"; "Half a glass is enough for me"; "Mother, the water from the hose is running down the gutter"; "We watered the garden yesterday. It doesn't need water today."

3. Are they interested in learning where their water supply comes from; whether there is much or little water available; and how the supply may be protected and preserved for the future?

4. Do they show an understanding of restrictions, such as not washing cars and watering lawns only twice a week, which are necessary in times of short water supply?

5. Do they show a desire to use wisely recreational water facilities, such as beaches, ponds, rivers, and lakes? Do they try to do their part to keep them attractive and free of debris?

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Films

IRRIGATION FARMING. (EBF) b/w. Describes the need for irrigation in certain sections of the United States. Shows how Boulder Dam has provided water for this purpose.

LIFE ALONG THE WATERWAYS. (EBF) color. Shows the plants and animals which may be found near a New England brook and river.

WATER—FRIEND OR ENEMY. (InstInterAmAffairs) color. An animated film produced by Walt Disney Productions. Illustrates correct measures in keeping water supplies from becoming polluted. (Available for purchase only.)

Filmstrips

THE BROOK. (CurrF) color.
HOME FOR WATER PLANTS AND ANIMALS. (PSP) b/w.
STORY OF A RIVER. (PSP) color.
WATER: A CONSERVATION LESSON. (VEC) b/w.
WATER AND ITS WORK. (YAF) b/w.

Appendix

Materials and Equipment

The materials listed are items that are suggested in *Science Everywhere* and the Manual for carrying out science experiences and activities. The articles are generally available in the school, the children's homes, or local stores.

Aquarium

Baking soda
Balloon
Bell, electric
Bowl or wide dish
Bulbs, low-voltage electric light

Coal
Cold-water paints
Comb, plastic
Compass
Cooking fat
Corks
Crayons
Cup, tin

Dry cells, 2 or 3 No. 6

Flowerpots or other containers for plants

Globe
Heat source, e.g., electric hot plate or Sterno set

Magnets, several in different shapes
Magnifying glass
Maps, wall, road, other
Marbles
Mirrors, small
Modeling clay

Nail, 8- or 10-penny
Nails
Needles, steel, knitting and darning

Paint, house
Paper: chart, colored construction, and drawing
Paper clips
Pennies
Pictures of animals
Pins, steel
Prism
Pumice

Ruler

Salt
Sand
Saucepan, glass
Scissors
Screws, several small
Seeds: bean, corn, tomato, sunflower, violet, zinnia
Soap
Sockets for low-wattage electric light bulbs
Soil, for planting
Soil samples
Sponge
Stand for free-swinging magnet
String
Sugar

Tacks
Tape measure
Thermometers, 2, Fahrenheit
Thread
Tin can
Tumblers
Turpentine

Wire, insulated copper doorbell
Wood, small blocks

Yardstick

Equipment Supply Houses

Carolina Biological Supply Company, Elon College, North Carolina. Living and preserved materials, plastic mounts, charts, and apparatus.

Central Scientific Company, 1700 Irving Park Boulevard, Chicago, Illinois, and 79 Amherst Street, Cambridge A Station, Boston, Massachusetts. General equipment: magnetism, heat, light, hand lenses and reading glasses, copper wire.

Chicago Apparatus Company, 1735–43 North Ashland Avenue, Chicago, Illinois.

General equipment: magnetism, heat, light. Aquarium and terrarium supplies, living and preserved materials, charts.

FISHER SCIENTIFIC COMPANY, 711–732 Forbes Street, Pittsburgh, Pennsylvania, and EIMER AND AMEND, 633–735 Greenwich Street, New York, New York; in Canada, FISHER SCIENTIFIC COMPANY, LTD., 904–910 St. James Street, Montreal, Quebec. General laboratory appliances.

GENERAL BIOLOGICAL SUPPLY HOUSE, 8200 South Hoyne Avenue, Chicago, Illinois. Aquarium and terrarium supplies, living and preserved materials, charts.

NEW YORK SCIENTIFIC SUPPLY COMPANY, INC. 28 West 30th Street, New York 1, New York (formerly New York Biological Supply Company). Preserved and living materials, and chemicals.

SOUTHERN SCIENTIFIC COMPANY, INC., Atlanta 3, Georgia. General equipment.

WARD'S NATURAL SCIENCE ESTABLISHMENT, INC., 3000 Ridge Road East, Rochester 9, New York. Living and preserved materials and apparatus, rocks, and fossils.

W. M. WELCH SCIENTIFIC COMPANY, 1515 Sedgwick Street, Chicago 10, Illinois. General equipment.

Directory of Publishers

ABELARD-SCHUMANN, LIMITED, 404 Fourth Avenue, New York 16, New York.

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THE VIKING PRESS, 625 Madison Avenue, New York 22, New York.
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THE JOHN C. WINSTON CO., Winston Building, 1010 Arch Street, Philadelphia 7, Pennsylvania.

Film and Filmstrip Distributors

CMP	Carl F. Mahnke Productions, 215 East Third Street, Des Moines 9, Iowa.
Cor	Coronet Films, Coronet Building, Chicago 1, Illinois.
CurrF	Curriculum Films. Distributed by American Educational Projections Corporation, 1319 Vine Street, Philadelphia, Pennsylvania.
Dowling	Pat Dowling Pictures, 1056 South Robertson Boulevard, Los Angeles 35, California.
EBF	Encyclopaedia Britannica Films, Inc., 1150 Wilmette Avenue, Wilmette, Illinois; 5625 Hollywood Boulevard, Hollywood 28, California; 7250 MacArthur Boulevard, Oakland, California; 277 Pharr Road, N.E., Atlanta, Georgia; 161 Massachusetts Avenue, Boston 15, Massachusetts; 4902 Argyle Street, Dearborn Michigan; 7421 Park Avenue, Minneapolis 23, Minnesota; 202 East 44th Street, New York 17, New York; 463 West Main Street, Kent, Ohio; 2129 Northeast Broadway, Portland, Oregon; 1414 Dragon Street, Dallas, Texas.
EyeGate	Eye Gate House, Inc., 2716 41st Avenue, Long Island City 1, New York.
FH	The Filmstrip House, 25 Broad Street, New York 4, New York.
Gateway	Gateway Productions, Inc., 1859 Powell Street, San Francisco 11, California.
Heidenkamp	Heidenkamp Nature Pictures, 538 Glen Arden Drive, Pittsburgh 8, Pennsylvania.
IF	Instructional Films, Inc. See addresses listed under EBF.
Inst Inter-Am Affairs	Foreign Operations Administration, Institute of Inter-American Affairs, 815 Connecticut Avenue, Washington 25, D.C.
PSP	Popular Science Publishing Company, Audio-

	Visual Division, 353 Fourth Avenue, New York 10, New York.
SVE	Society for Visual Education, Inc., 1345 West Diversey Parkway, Chicago 14, Illinois.
VEC	Visual Education Consultants, Inc., 2066 Helena Street, Madison 4, Wisconsin.
VS	Visual Sciences, Box 599-HW, Suffern, New York.
YAF	Young America Films, Inc., 18 East 41st Street, New York 17, New York.

TAPE RECORDINGS	Department of Audio-Visual Instruction, National Education Association, 1201 16th Street, N.W., Washington 6, D.C.

National Film Rental Agencies

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Instructional Films, Inc. See addresses listed for Encyclopaedia Britannica Films, Inc.

International Film Bureau, Inc., 57 East Jackson Boulevard, Chicago 4, Illinois.

Nu-Art Films, Inc., 247 West 46th Street, New York 36, New York.

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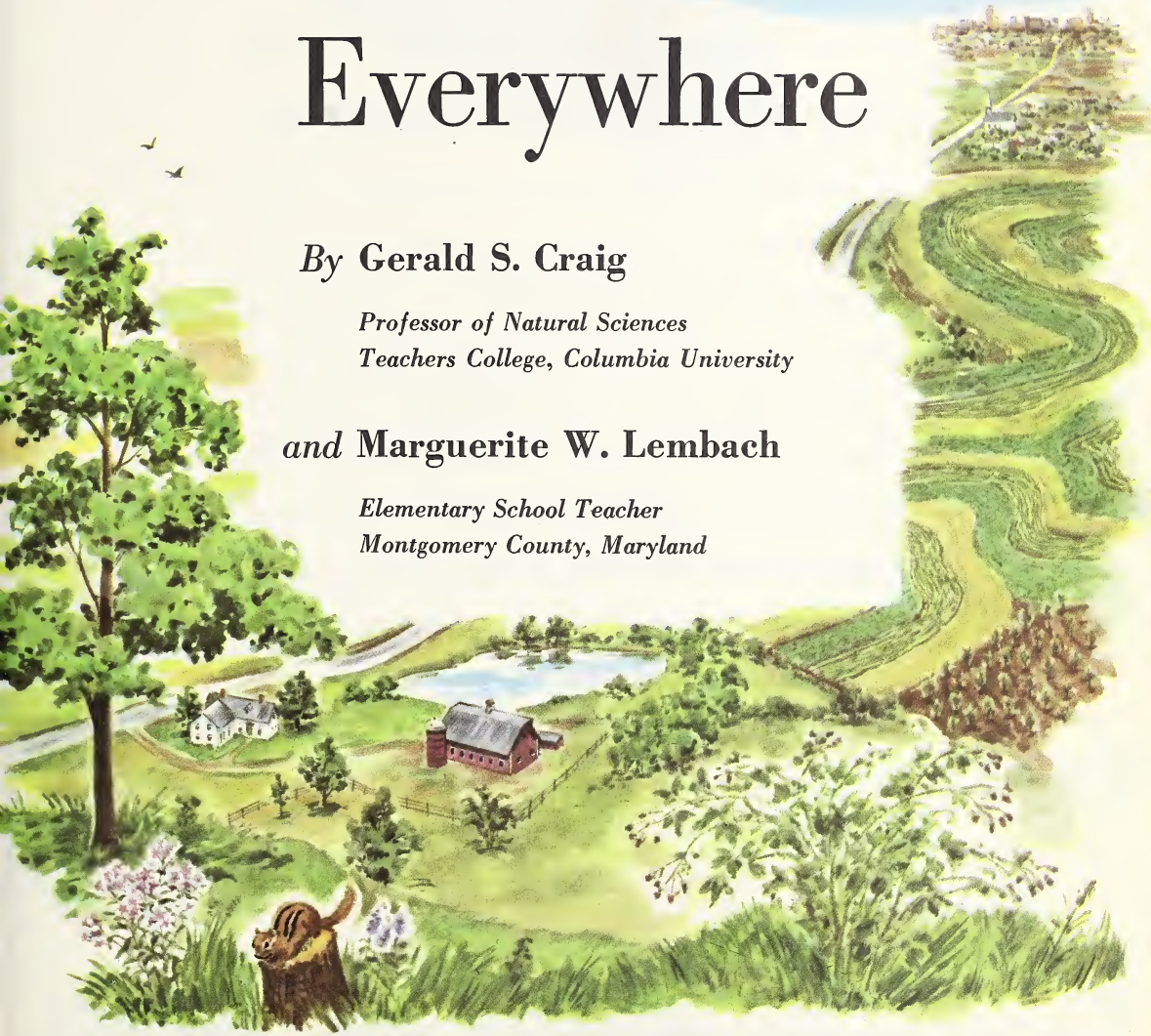

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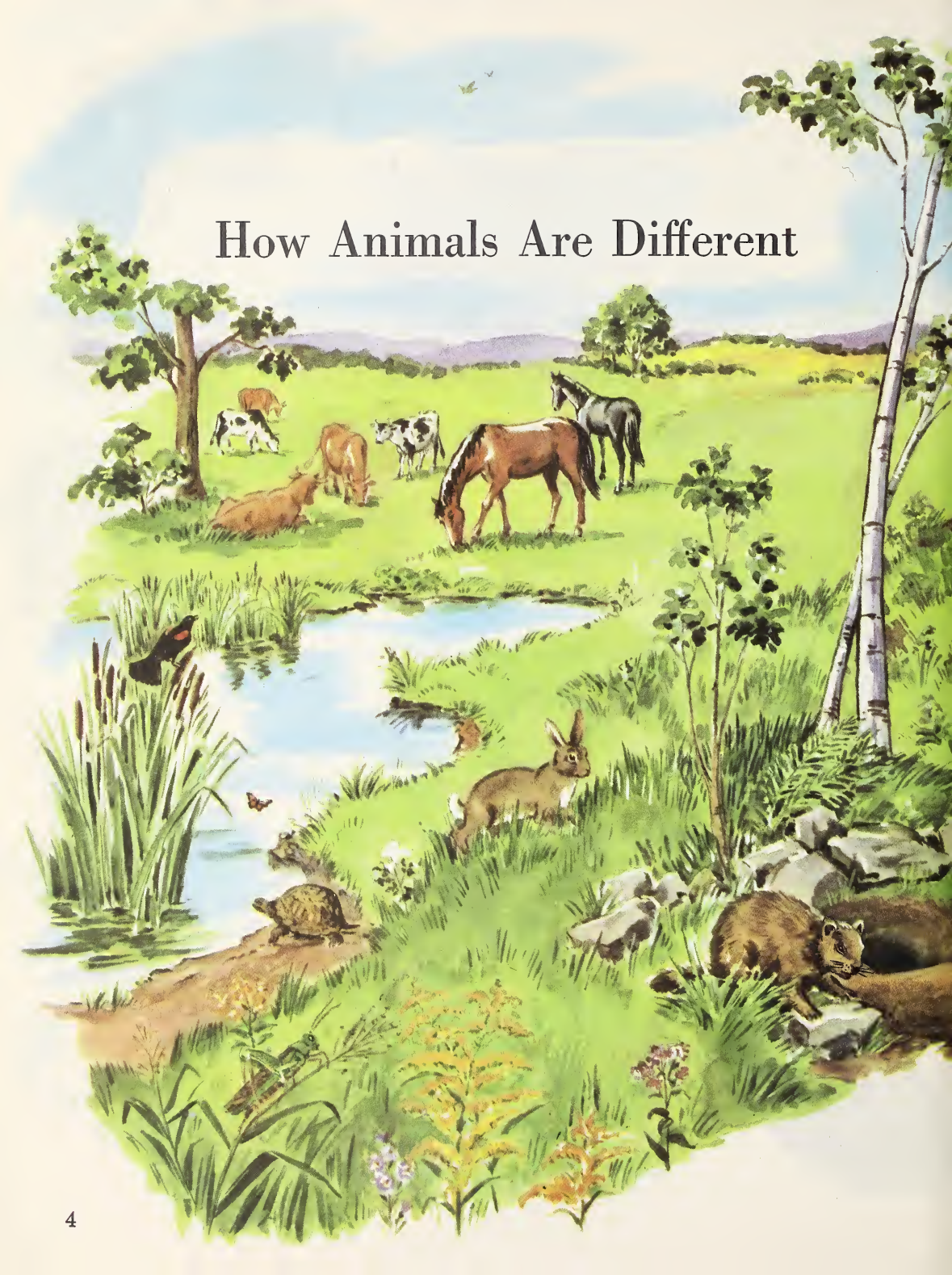
How Animals Are Different



Many Kinds of Animals

Many different kinds of animals live on the earth. There are animals large and small. There are animals short and tall.

Some animals are covered with fur. Some are covered with feathers. And still other animals have scales or shells to cover them. Do you know any animals that have scales or shells?

Look at all the animals in the picture. What large animals do you see? Can you see any small animals with scales or shells? Which animals have fur to cover them? Do you see any animals with feathers?

How many of these different animals do you know?

Think about the many kinds of animals you have seen. Have you a pet dog or cat or rabbit? Do you enjoy your pet?

Have you seen cows, horses, and sheep in the country? Have you seen chickens, ducks, and turkeys?

What animals have you seen at the circus? Tell the boys and girls about these animals.

What animals have you seen in a park? Are these large or small animals?

Make a list of all the different animals you can name. Ask your teacher to help you. Ask your teacher to help you to write their names.

You will enjoy the next part of the story about animals more if you write your list now. Then you may use your list as you read the story.

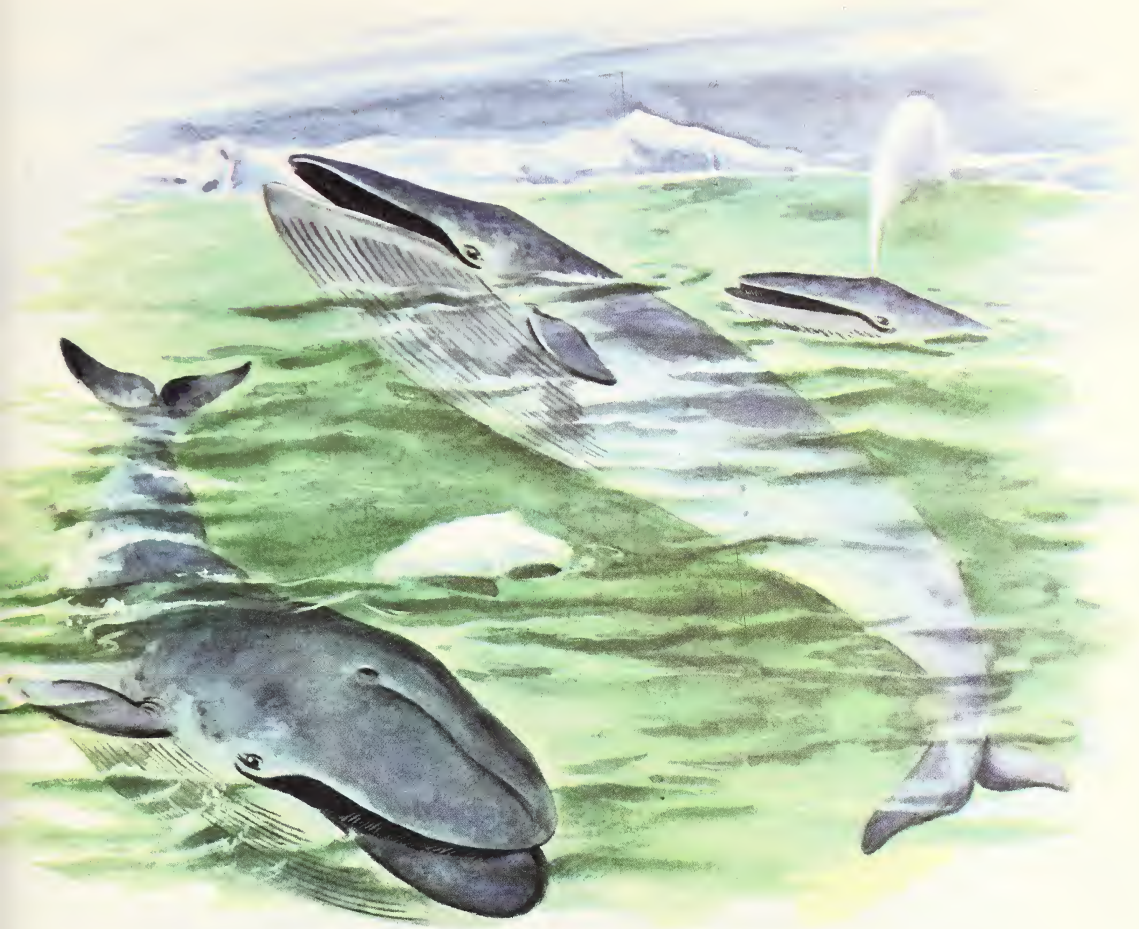
Animals Large and Small

Some animals are very large, and some are very small. Which animal on your list is the largest one? Which animal is the smallest one?

Some animals are smaller than any you may have put on your list. Here are pictures of small animals. Which ones do you know?

Some animals are so small that you cannot see them without looking at them through a magnifying glass. Can you think of an animal as small as that?

Other animals are very large. Some are so big that you could not get them into your room at school. Do you know of any animal as large as that?



Learning About Large Animals

Scientists think that a blue whale is the largest animal which has ever lived on the earth or in its waters.

A blue whale is too big to get into your schoolroom. It is too tall and it is much, much too long.

Even a baby whale is very large.

You may think that an elephant is a large animal. It is very large. But if an elephant could stand beside a whale, you would see that the elephant is very much smaller. A whale is much bigger than an elephant.

When you stand next to a grownup, that person seems large. But if a grownup stands beside a very big elephant, that person seems small.

Both a whale and an elephant are much larger than a person.

Here is the way a whale, an elephant, a man, and a boy would look if they could stand side by side.

A blue whale sometimes grows to be one hundred feet long. This is very long for an animal.

Try to measure one hundred feet on the playground. In this way you can find out just how long a blue whale may grow.

Whales live in the ocean. They can swim and float easily in the water. The water helps to hold them up. Whales are so large and heavy that it would be very hard for them to move about on land.

Large whales sometimes weigh one hundred and fifty tons. This is about the same as one hundred and fifty cars would weigh. Think of one animal weighing as much as one hundred and fifty cars!

You may know of some other large animals too. Horses and cows are large animals. Bears and lions are large animals. But they are not so large as a blue whale.

A whale is the largest animal living on the earth, but a giraffe is the tallest. Even a young giraffe is often taller than a grown person.

Some giraffes are three times as tall as a grown person. Do you think a giraffe could stand up in your room at school?

Look at the giraffe nearest you in the picture. See its long legs. And look at its long, long neck.

With its head so high, a giraffe can see all about it. It can tell if danger is near. Then, with its long legs, the giraffe may go away to a safe place.

Giraffes eat the leaves which grow on tall trees. With such a long neck, a giraffe can reach its food. This is an easy meal!

A giraffe may look queer to us, but long legs and a long neck are very helpful to this animal.

These animals are bison. A bison is a large animal. A bison is not so large as a whale or an elephant, but it is much larger and much heavier than a grown person.

An elk is another very large animal. It stands as tall as a horse. But an elk has very big antlers. These antlers make an elk seem much larger than a horse. What other large animals with antlers do you know ?

When you stop to think about it, there are many large animals on this earth. What large animals have you seen ?

Learning About Small Animals

Look at the small animals at the right. Have you ever seen animals like these? They are often called prairie dogs. A prairie dog is only six or seven inches tall.

These little animals are not really dogs. They are ground squirrels. But because they make a barking sound, some people have given them the name *prairie dog*.

If your home is on the prairie, you may have seen some of these small animals.

A mud turtle is a small animal, too. It likes to stay near ponds and brooks. Mud turtles may be small, but they know how to get an easy meal. They often eat the worms fishermen use when they go fishing.

If you live near a pond or brook, look for this small animal the next time you play there.

A hummingbird is another small animal. In the picture you see a grown hummingbird. It is not much larger than the flower it is near.

A hummingbird is a very small animal, but it can do many things that larger birds do. A hummingbird can fly many, many miles without stopping. It flies hundreds of miles over the water each year to go from its summer home to its winter home.

The hummingbird is one of the smallest of all birds. It is one of the fastest too. When it flies a hummingbird often moves its wings so fast that they cannot be seen clearly.

A grown hummingbird is about three inches long. Young hummingbirds are even smaller. Two or three baby hummingbirds can be held in a spoon.

A hummingbird makes a very small nest. It is often not much more than one inch across. Such a nest looks like a tiny cup.

A hummingbird often builds its nest on a tree branch. The bird covers the nest with small plants. The nest is very small and cannot always be seen. It looks like a part of the tree branch.

A hummingbird may use spider webs in building this small nest. The inside of the nest may be covered with the soft part of plants, called plant down. The baby birds stay in the soft nest until they can fly.

Another small animal is a field mouse. It is so small that it can hide in the grasses of a meadow or field.

A field mouse may be very small, but it eats and eats. Sometimes a field mouse will eat nearly as much as it weighs in one day.

An earthworm is a very small animal, too. There are hundreds and hundreds of these small animals in the soil.

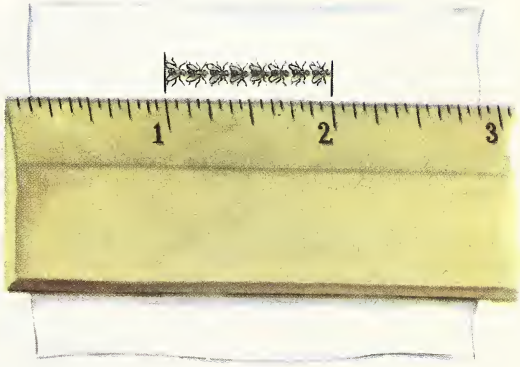
You may have seen earthworms when they came to the top of the ground after a very hard rain. Earthworms may be small, but they move tons and tons of soil as they push through the earth.

Ants are small animals, too. There are many kinds of them. The ants in the picture are taking bread crumbs to their anthill. They are not much larger than the bread crumbs.

Another smaller animal is a little fruit fly. It is even smaller than an ant. It often lives on fruits. You may see fruit flies near fruits in your home or around the fruits in a food store.

How small a fruit fly is! You must use a magnifying glass to see it well. Here is the way one might look through a magnifying glass.

Make two marks, one inch apart, on your paper. You could put eight fruit flies between the marks. Think how small the flies would be!



Some people think that these little flies are baby flies. But they are not. They are grown flies. They will not get any larger. Eight fruit flies in one inch! These are very small animals.

Animals Have Many Shapes

Animals have many, many shapes. Some of these shapes are very surprising.

There are animals which look like small brown sticks. There are others that look like the stems of a green plant. These animals look like a thin stem.

There are some animals that are shaped like flowers. Some animals are shaped like stars. There is another animal, which looks like a ball of stickers.

Some animals look like dead leaves on a plant. Did you ever think there could be so many different animal shapes?

In the picture you can see other animals with different shapes. As you look at the picture, you may think, "What a pretty garden! What bright colors! I have never seen flowers like these before. But where are the animals? I don't see any in this picture."

You may be surprised to know that this is a garden of animals and not a garden of flowers. The animals are brightly colored. What colors do you see?

These animals live in the sea. They look very much like flowers. Because they have the shapes and colors of flowers, they are sometimes called sea flowers.

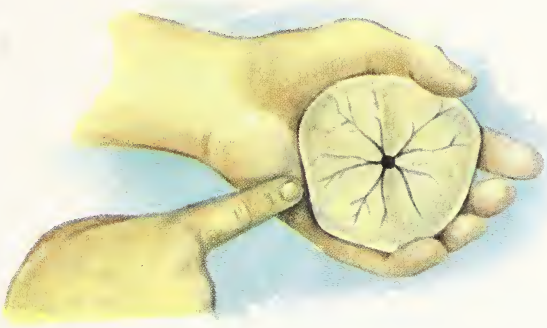
In the picture you can see some animals with a strange shape. If you have played along the seashore, you may have found some of them on the sand.

People sometimes call these animals sea cookies. They are round and flat, like cookies, and some of them are a light brown in color.

Other people think these strange little animals look like round silver dollars. For this reason they are sometimes called sand dollars.

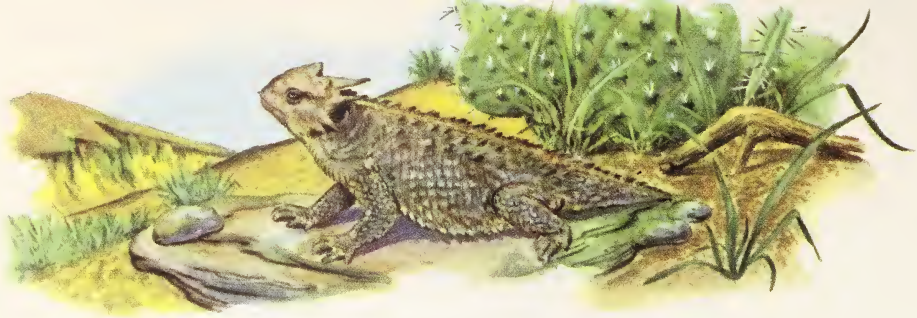
Sand dollars are often washed up on the shore by the waves. They have no arms or legs such as you have. They cannot move very far alone. Sand dollars go where the waves take them.

The sand dollar is a little, thin sea animal. On the underside of this animal there is a small hole. This is the sand dollar's mouth. All the food this little animal eats goes in through this little hole.



On the top of the sand dollar there is a pattern which looks like a flower. If you look carefully, you can count the five parts of the pattern.

Little holes make the pattern on the sand dollar's back. The sand dollar breathes through these holes. The sand dollar has a strange shape for an animal.



This strange-looking animal is a horned lizard. It is covered with many sharp horns, which give the animal its name. The horned lizard lives where it is dry and sunny. It sometimes hides under rocks. If you do not look carefully, you may think the horned lizard is a sharp, brown rock.

Here is an animal which looks as if it were covered with pins. Do you know the name of this animal? It is a porcupine.

Look out for the porcupine's stickers! They feel as much like pins as they look.

What strange-looking animals can you see near your home?

Here is another animal with a strange shape. It is a garden slug. You may have seen it in your garden.

This animal can change its shape. A slug can pull its body up until it is short and fat. Or a slug can make its body long and thin.

The animal in the picture is a dragonfly. Have you ever seen an animal like this?

A dragonfly looks something like a toy airplane. Its big wings and thin body make it look strange to us. But they are very useful to this animal.

A dragonfly uses its wings to help it move about to get food and fly away from danger. Its thin body is not always seen by animals which might eat it.

This shape is just right for a dragonfly.

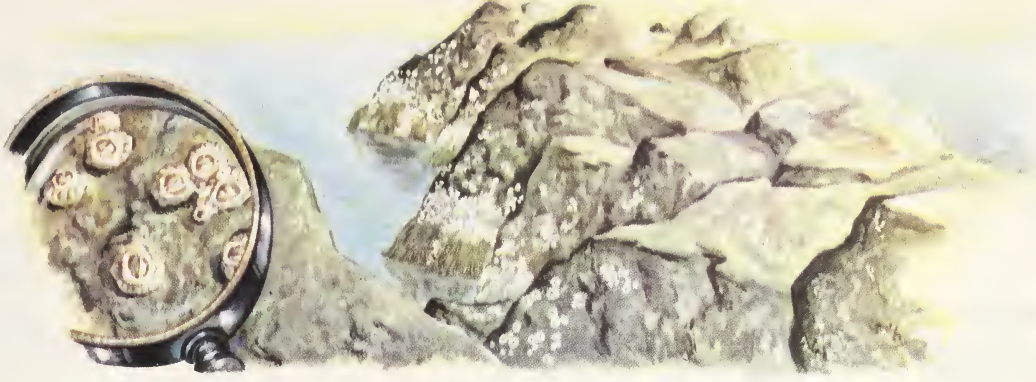
Have you seen the animal in this picture? It is a caterpillar. But what a strange shape it has!

Its body goes up in the middle like a loop. And it has feet on both ends, but no feet in the middle.

This animal has three or four names. All the names come from the way it walks. Because it has no feet in the middle, this caterpillar walks first with the feet on one end of its body. Then it walks with the feet on the other end.

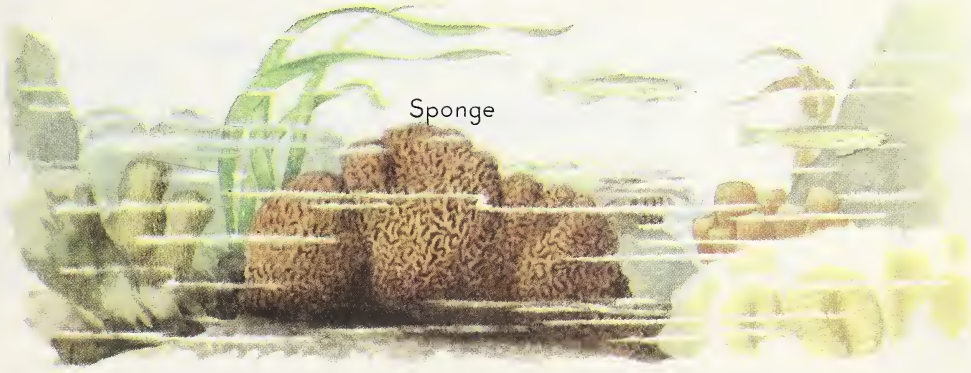
As the caterpillar walks, it seems to loop along, or inch along as if it were measuring something. For this reason, it is called a looper or an inch worm or sometimes a measuring worm.

Think of all these names for a small caterpillar with no feet in the middle of its body!



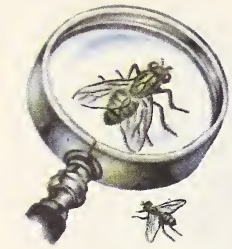
The shape of a rock barnacle may seem strange to you. This animal looks like a piece of shell or white rock. Inside each barnacle shell there is a very small animal. You do not see any of the animal but its shell.

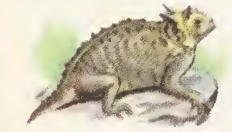
Rock barnacles live on the rocks along the seashore. When a rock barnacle is very young, it fastens onto a rock. There it stays for the rest of its life. The rock barnacle cannot move from the rock.



Look at the sponge in the picture. Did you know that a sponge is an animal? Sponges are very different from the animals you have read about in this story.

Sponges have no head or feet. They do not move about, as many other animals do. Sponges fasten onto rocks and other things under the water and stay in one place.





Animals All

You have been reading about many different kinds of animals.

There are animals so small that you need to look through a magnifying glass to see them well.

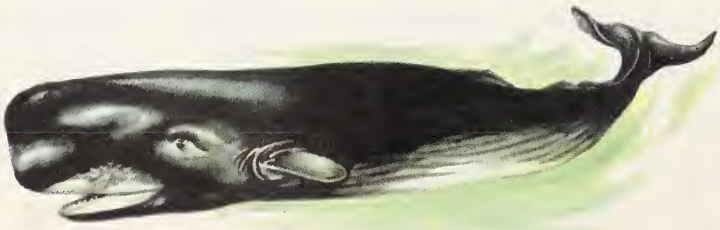
There are animals that grow to be one hundred feet long. There are other animals that are more than three times as tall as a man.

There are animals of all sizes in between.

There are animals with many shapes. Some animals look like flowers. Some look like sticks, twigs, or plant stems. One looks like a star. And one looks as if it were covered with sharp pins.

There are land animals and there are water animals.

How different from each other some living things can be! But the different living things you read about in this story are all animals.



Do You Remember?

1. Can you name four animals larger than a sheep?

2. Can you name four animals smaller than a hummingbird?

3. What animal can change its shape?

4. Name three animals in the story which have sharp stickers.

5. Which animal in the story is the largest?

6. Which animal is the tallest?

7. Name three animals in the story which live in the water.

8. In what way are all these living things the same?

Something to Do

1. Look at the list of animals that you made after you read page 7.

How many animals on your list are large animals?

How many of them are small animals?

Do any of them have strange shapes?

2. Make pictures of the different animals that you have learned about in this story.

3. What strange-looking animals can you see near your home?

How Animals Get Food

Many Ways to Get Food

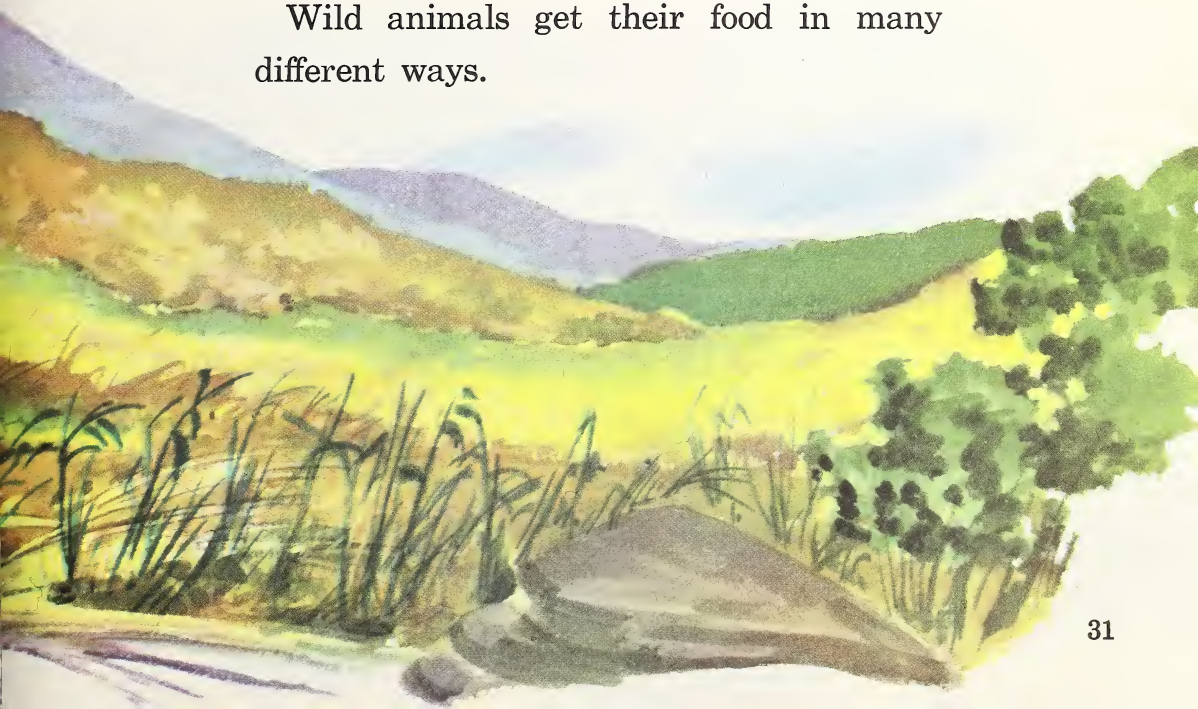
When you are hungry, you may ask Mother for an apple or a cookie. If it is near mealtime, you may smell all the good smells of food.

It is easy for you to get food. You do not need to hunt for it, as most animals do. Mother and Father get the food you need.

If you have a dog or cat, you take good care of it. You see that it gets enough to eat. Your pet does not need to hunt for its food.

Wild animals need food, too. They have no one to feed them. They must find food for themselves.

Wild animals get their food in many different ways.



Some animals get their food as they fly through the air. Can you think of any animals that get their food in this way? What do you think the food might be?

Look at the picture. It may help you to find out.

The birds in the picture are barn swallows. They fly through the air with their mouths open. As the birds fly, they catch the small insects that are flying in the air, too.

A barn swallow can fly fast. It can fly this way and that, — up and down, — so that it can catch insects.

There are other animals which get their food in much the same way. Can you think of one?

You may think that this is a strange way to eat. You would soon grow hungry if you had to go after your food in this way. But a barn swallow is well suited to getting its food as it flies.

Wolves and coyotes can run fast. Wolves and coyotes go after their food quickly, just as the barn swallows do. But wolves and coyotes travel on the ground, not through the air like swallows.

Wolves and coyotes run after many animals. Sometimes they can run faster than the animals they want for their food. Do you think the wolf in the picture can run faster than the woodchuck ?

What other animals run after their food ?

Owls and some other birds use their feet to catch their food. Their feet are very strong, and they have very sharp claws on them.

An owl hunts for its food after the sun goes down. It flies along near the ground, and watches for the small animals which live in the fields and woods.

When an owl sees an animal to eat, down it flies. Up and down go its wings.

The strong, sharp feet catch the animal, and the hungry owl soon has its supper.

Did you ever watch some ducks eat? Here is a picture of some farm ducks on a pond.

It is mealtime. When these ducks are hungry, they can tip upside down in the water. They eat the plants growing under the water.

This way of getting food is very good for ducks such as these.

How do you think an elephant gets its food? It uses its nose. Think of using your nose to get your food!

An elephant's long trunk is its nose. With its trunk an elephant can pull up grass and other plants to eat.

Up comes the grass. Around and under goes the trunk. The elephant opens its mouth. And in goes the grass.

What a help an elephant's trunk is in getting its food!

A pelican is a bird that eats fish. It flies above the water to look for fish.

Sometimes a pelican flies so low that its wings are just above the water. At other times it flies high in the air.

As it flies, the pelican sees a fish in the water below. Straight down it goes into the water with a SPLASH!

This is a wet way to get food, but it suits the pelican very well.

A butterfly gets its food by sucking the sweet nectar from flowers.

A butterfly has a long, long tongue. Its tongue is very much like a thin straw.

To get nectar, a butterfly sits on the plant and puts its long tongue into the flower. Then it sucks the nectar from the flower in much the same way that you suck milk through a straw.

When a butterfly has sucked the nectar, it rolls up its long tongue and flies away to another flower.

Can you see why a butterfly needs to have a tongue that is like a thin straw?

How Do These Animals Get Food?

Here are some animal pictures. Each of these animals has something to help it to get its food.

Look carefully at each animal. Does its nose, its feet, its claws, its tongue, its teeth, or its mouth help it to get food?

What does each picture tell you about the way the animal gets its food?

You will want to talk about the animals in these pictures with your teacher and the other children in your room.

Then you may want to make pictures to show how each of these animals gets its food.

How Animals Escape from Enemies

Some Animals Go Away from Their Enemies

Nearly all animals have some enemies. They escape from their enemies in many different ways.

Some animals escape from their enemies by running away. A deer can sometimes run faster than the wolf or coyote which is running after it. A rabbit can sometimes run faster than a fox. Then running away is a good way to escape.

A frog may escape from an enemy by jumping into the water and swimming away quickly.

Many birds escape from their enemies by flying into the air. They fly away where their enemies cannot reach them.

Woodchucks and chipmunks go into their holes when they know danger is near. Most large enemies cannot follow the woodchucks and chipmunks into their small holes.

Moving off quickly is a good way for some animals to escape from their enemies.

Another Way to Escape

Some animals look very much like the places in which they live. They are often the same color as many of the things around them. This makes it hard for their enemies to see them.

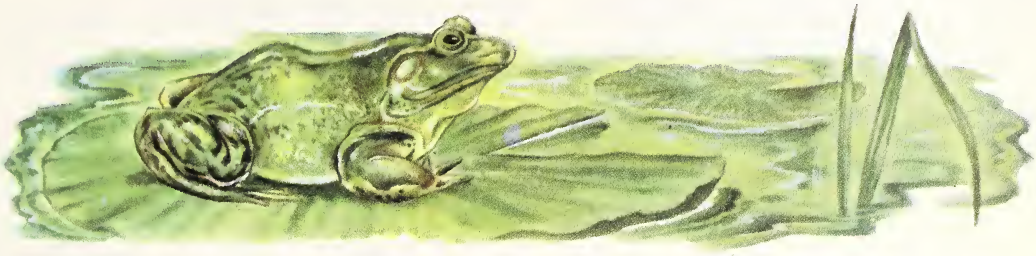
These animals do not need to run away from their enemies. They just stay very still. Often their enemies may be near and not see them.

A quail is a bird smaller than a chicken. It lives in the high grasses and bushes. A quail has spotted feathers. When it sits very still among the spots of sunlight and shadows in the bushes, you may not see it at all. Very often a quail's enemy does not see it.

You can see from the picture how well a quail's color hides it from its enemies.

A green frog, sitting on a green plant in water that looks green, may escape from its enemies.

The frog's colors are so much like the other colors around it that its enemies may not even see it.



Some garden spiders are brightly colored. These spiders live in webs among brightly colored flowers. The spider's colors and the colors of the flowers are very much alike. This makes the spider hard to see.

As long as it stays in its web among the colored flowers, the spider may escape.

A garden spider could be seen easily on a brown rock or on brown soil.

Look at the two pictures below. In which one can you see the spider more easily?

What do you think might happen to this spider if it stayed on a brown rock or on brown soil for very long?

Is the spider safe here?

Some Animals Go into Shells

Some animals escape from their enemies in another way. They do not hide. They do not run away. They close themselves inside a hard shell until the danger is over.

In the picture, how does the turtle escape from the dog?

What happened to the turtle's head and feet and tail? Where did they go? Why can't the dog get at the turtle?

Some snails escape from their enemies by going into their shells. Sea animals such as oysters close themselves inside a hard shell to escape from their enemies.

What other animals besides oysters do you know that have shells?

COURTNEY ALLEN

Some Animals Have Quills

A porcupine's very, very sharp quills help it to escape from its enemies. The quills cover the porcupine's back and tail. They come out of the porcupine's body easily.

When an enemy comes after it, the porcupine turns its back. It puts its nose near a log or a rock. Then it swings its tail back and forth, and all the quills stand up.

If an enemy gets too close, that tail strikes it. Then the quills come out of the porcupine and stick in the enemy. Here is the way a porcupine quill looks through a magnifying glass. The hooks on the end stick into the enemy.

Losing the sharp quills does not hurt a porcupine. It can grow more quills. But the enemy does not like the sharp, sharp quills sticking in it. The quills hurt!

Some Animals Fight

Animals have many different ways to fight their enemies. Cats use their claws and teeth for fighting. Lions fight with their teeth and claws, too.

Some animals have horns and fight with them. If you have ever been bumped by a goat, you know how well a goat can use its horns.

Hoofs are very useful to some animals. Bison fight with their hoofs, as well as with their horns. Horses fight with their hoofs. A donkey uses its hoofs for fighting, too. Look at the picture to find out how a donkey fights with its hoofs.

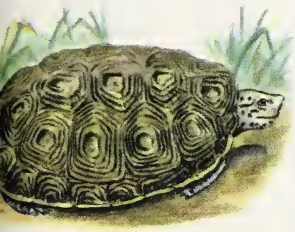
These animals fight with a sting. They sting their enemies. What other animals can you name which fight with a sting?

There are other ways in which many animals fight their enemies. Can you think of any other ways of fighting?

What Is the Best Way to Escape?

Look at the animals in the pictures on this page. Can you tell how each one escapes from its enemies?

Which one do you think would fly away from its enemies?



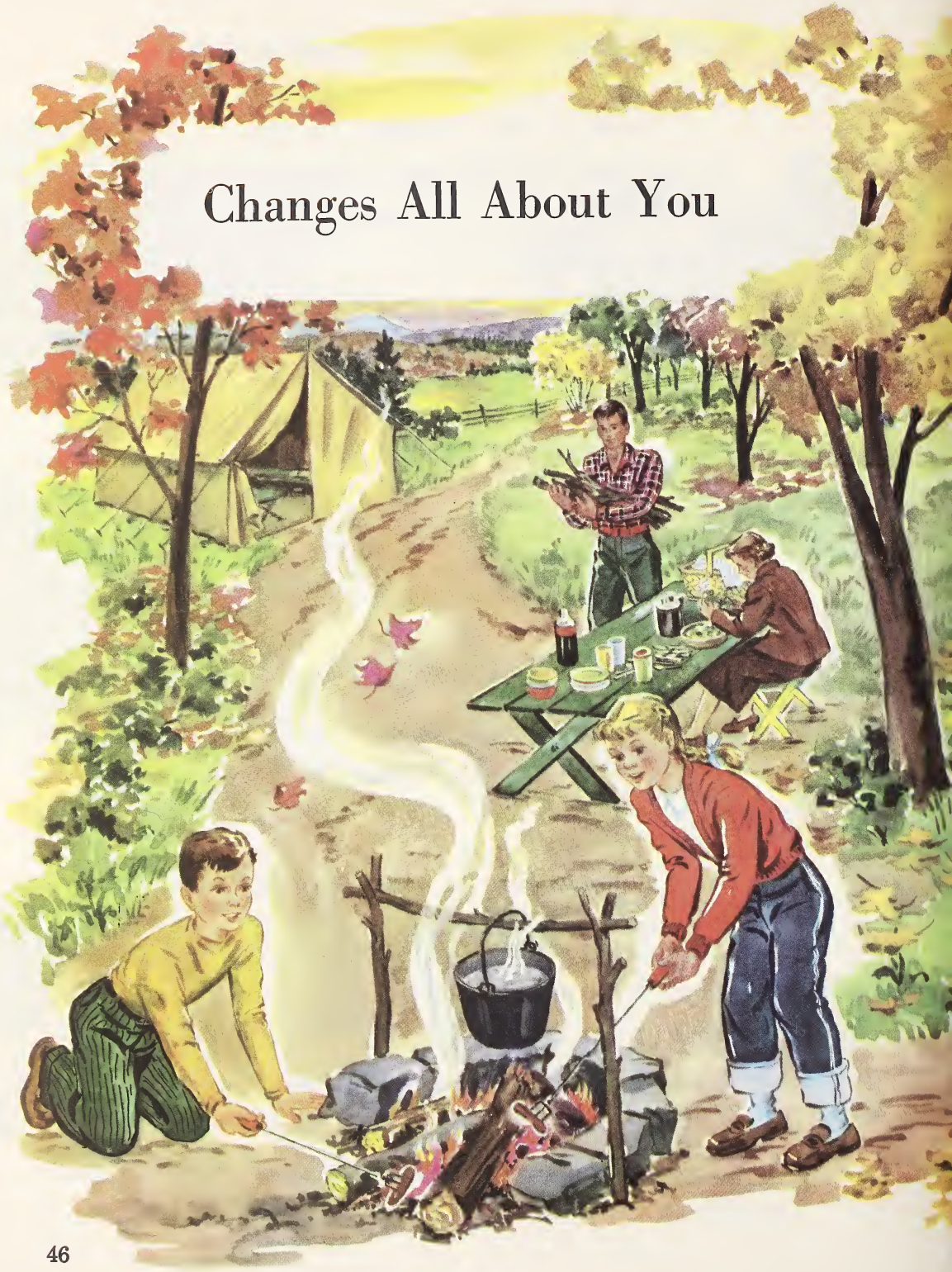
Which ones might stay and fight their enemies? How would they fight?

Which animal might escape by just staying very, very still?

Can you find an animal which might escape inside its hard shell?

There are many, many ways for animals to escape. But each animal escapes in the way best suited to it.

Changes All About You



Many Real Changes

There are many, many changes going on about us all the time. They are just as wonderful as the changes which happen in stories. But they are real changes. They happen without magic. They happen without a magic stick or a magic sign.

There are changes in the sky. The sky grows darker as night comes. There are changes again in the sky when it is morning, and we see the sun.

There are changes in the weather. Some days are cool, and some are warm. There are cloudy days. Others are sunny. Can you think of other changes in the weather?

The children in your room at school may change. Some may move away. New boys and girls may come into your room.

What other changes do you know about? What changes are going on in the picture?

Evaporating Is a Change

Early one morning Fred went into the garden. He put some water into the birdbath. Many birds flew to the birdbath. The birds drank and drank from it. They splashed about in the water.

The hot summer sun shone all day. It shone down on the garden. It shone on the water in the birdbath. The warm summer wind blew through the garden. It blew over the water in the birdbath.

Late in the afternoon Fred came into the garden again. When he looked at the birdbath, he was surprised to see that it was empty. All the water had disappeared.

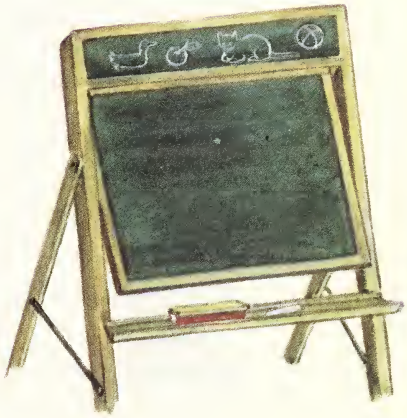
Do you know where the water went?

The birds drank some of the water. They splashed some of it on the ground. But most of the water evaporated. It went into the air.

Mary was in her playroom. She was washing the blackboard with a wet sponge. As she rubbed, the sponge made a wet streak.

Mary watched, and the wet streak faded and faded until it was gone. Mary made another streak with the wet sponge. In a very short while this streak faded away, too.

Can you tell what happened to the water that Mary put on the blackboard with the wet sponge? Is this the same thing that happened to the water in Fred's birdbath?



The water evaporated from the birdbath. It disappeared from the blackboard. It went into the air from both the birdbath and the blackboard. This was a real change. It was a change Mary and Fred could see.

Where have you seen water evaporate?
Where have you seen this real change?

Rusting Is a Change

David left his skates in the yard one afternoon. That night it rained. The next morning, when he went to get them, there were brownish-red spots on the skates. David picked up his skates. Some of the brownish-red spots rubbed off on his fingers.

He called to his father to come and see what had happened to his skates. "They were shiny when I left them here," he said. "Now they are full of brownish-red spots of rust. Look — the rust rubs off on my fingers."

"Yes, David," said Father. "Some things made of iron will rust in the places where water gets on them. Your skates are made of iron. They got wet in the rain last night. The rain changed some of the iron in your skates to rust."

What Will Rust?

Things with iron in them rust when they get wet. Other things will not rust in water. You may find out that some things rust and that others do not.

Put water in six glasses and place them on the table. Put these things in the glasses:

Leave the six glasses, without moving them, for two or three days. What will happen to the paper clips? What will happen to the comb and to the pennies?

After two or three days look at the things in each glass. What changes can you see? Which things rusted? Did the paper clips rust? Did the comb rust? Did the pennies rust? Can you tell from this experiment which things have iron in them?

Freezing and Melting Are Changes

Mother took some ice cubes from the refrigerator. How cold and hard they were! They made a clinkety sound as she dropped them into a pitcher.

Patsy filled the ice-cube pan with water. Then she put the pan into the refrigerator again. "Soon we shall have more ice cubes," she said.

"Yes," said Mother. "We put the water into the ice-cube pan of the refrigerator, and after a few hours we take out ice."

Water gets very cold in the refrigerator. It freezes and gets hard. When water freezes, it changes into ice. This is a real change.

" Water must be cold to change into ice," said Patsy. " It must be so cold that it will freeze.

" But I can make the ice change. I can make it change into water again."

Look at the picture. What is Patsy doing with the ice? What do you think will happen to the ice cubes?

What has happened to the ice cubes in this picture? How have they changed?

" Look," said Patsy. " The ice has melted. It is not cold or hard any more. The ice has changed to water again.

" Away goes the ice. Back comes the water. Melting is a real change."

Burning Is a Change

When some things burn with fire, they change. Papers change when they burn in a paper burner. Wood changes when it burns in a campfire. Coal in a fireplace changes as it burns.

What is left in the paper burner and the campfire and the fireplace after these things have burned? How has the paper changed? What does the wood look like now? What has happened to the coal?

All three things have changed in the way they look and feel. Burning has changed the paper, the wood, and the coal to ashes. Now there are paper ashes, wood ashes, and coal ashes.

Decaying Is a Change

Andy was in the woods with Father. They were getting humus for the garden.

"There is much plant food in humus," said Father. "Humus is good for a garden."

"What is humus?" asked Andy.

"Take some in your hands and look at it closely," said Father. "You may find out."

What do you find in humus?

Twigs, branches, and small pieces of bark fall from the trees each year. The insects die. They die among the leaves each year. After they die, they decay. The leaves, twigs, and bark decay. They break up into small pieces.

Decaying changes these plants and animals to humus. The humus makes a carpet under the trees in the woods.

Dissolving Is a Change

Some things change when they are put into water. They go into the water. Then they seem to disappear. This change is called dissolving.

Sugar and salt dissolve in water.

Soap dissolves in water, too.

What other things can you think of which dissolve in water?

Some things will not dissolve in water. But they will dissolve in turpentine.

The paints often used on houses and barns will dissolve in turpentine.

The turpentine dissolves the paint and makes it easy to rub off. You can clean house paint off your hands with turpentine, too.

On this page are pictures of some things which will dissolve. Most will dissolve in water. One of them will not dissolve in water, but will dissolve in turpentine.

Growing Is a Change

Some changes happen quickly. Ice melts in a warm place. House paint dissolves in turpentine. Wood burns in a campfire. These changes take only a few minutes.

There are other changes, which go on very slowly. Some of the slow changes take years and years and not just a few minutes.

You may not know it, but you are changing, too. You are growing. Growing is a slow change for people. You grow little by little and change as you grow.

How old are you now? You have not always been as old as this. Each day you are a little older. Every year on your birthday you mark that change. Each year on your birthday you put one more candle on your birthday cake.

How tall are you, and how much do you weigh? You have not always been this size. You have not always weighed the same. You grow and change every day.

See how much you have grown by trying to put on your last year's clothes. Do they fit? Where is the change if your clothes do not fit? Is the change in you or in the clothes that do not fit?

These changes may be slow, and they may be small. But they are real changes.

Animals Grow and Change

A puppy grows up to be a dog.

A kitten grows into a cat.

A tadpole changes into a frog.

All these animals grow faster than you do. They all change as they grow. But a puppy, a kitten, and a tadpole grow and change faster than a person does.

It takes less time for a puppy to grow into a dog, or a kitten to grow into a cat, or a tadpole to grow into a frog, than it takes for you to grow up.

Plants Change as They Grow

You have seen how animals change as they grow. Plants change, too, as they grow. You may watch these changes in plants as they grow from seeds.

Plant a bean seed in a box of garden soil. Water the seed when the soil is dry. Place the box where it will get some sun each day. Then watch for the changes that take place in the box. Keep a record of these changes.

You will want to find out these things for your record:

1. When did you plant the bean seed?
2. How many days went by before the new plant came through the soil?
3. Did your plant bloom?
4. How long did it take for the plant to bloom?
5. How long did it take for a bean to grow on your plant?

In the pictures below are some seeds and the plants that grow from them. The seeds look the way they would if you saw them through a magnifying glass. Try an experiment with seeds like these.

Plant some of the seeds. Watch the plants grow and change as the bean plant did.

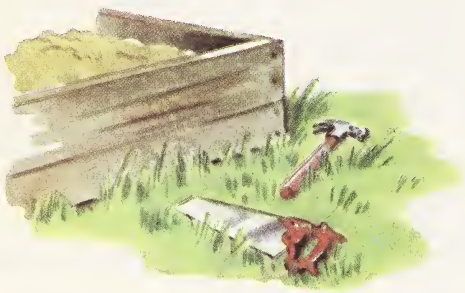
Watch the plants for a month or more to see how they change as they grow. You may find out more about these plants as you watch them grow and change.

Talk about these things with the other boys and girls.

1. What kind of plant will a corn seed grow into?
2. Will one kind of seed grow faster than another?
3. Will all the seeds grow?
4. Which will you see on the plant first, the flowers or the new seeds?
5. Do you know which part of the plant will change to make the seeds?
6. Will all the plants make seeds?
7. Will all the plants bloom?

Changes You Can See

Mike has some tools made of iron. He left them in the grass by the sandbox. How will the tools change if they are left like this for very long?



Jane has finished painting her picture. She closes the paint jars. Why does she do this? What might happen if she left the jars open?

Sandy was washing her doll clothes. She left her cake of soap in the water while she put the doll clothes out to dry. How will the soap change if it stays in the water long?

Betty has a new pet rabbit. It is just a baby rabbit now. Betty will feed it and take good care of it. How do you think Betty's rabbit will look in six months? How will it change?

Some Things to Try

1. Put some water in two glasses. On the outside of each glass mark with a crayon the place where the water stands. Set one glass on the radiator and one glass on the floor away from the radiator.

Look at the glasses each day for four or five days. Mark the new place where the water comes on each glass. Make this mark with a different-colored crayon every day.

In which glass was the water lower at the end of four or five days? Did the water disappear more quickly from the glass on the radiator than from the glass on the floor away from the radiator?

2. Make a list of all the changes you can think of which happen quickly.

3. Make a list of all the changes you can think of which happen slowly.

4. Try to dissolve these things in water: sugar, salt, sand, house paint, cooking fat, a comb, soap, and garden soil.

5. Try to dissolve the same things in turpentine.

Using Magnets

Experimenting with Magnets

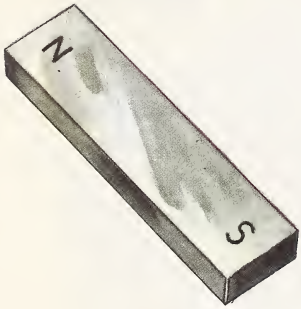
It is fun to experiment with magnets. You may have tried to pick up things with magnets as the children in the picture are doing.

A magnet attracts, or pulls, some things to it. Do you know what things a magnet will attract?

One way to find out is to experiment in your schoolroom. Use some of the things the children in the picture are using.

Hold your magnet near each of these things. Which of these things does your magnet attract?

Magnets Have Different Shapes



In the picture on page 64 the children are experimenting with magnets of different shapes. In the pictures on this page you can see the magnets better.

One magnet is shaped like the letter U, and so it is called a U magnet. Another magnet is straight like a bar. It is called a bar magnet. Still another kind of magnet is shaped like a horseshoe. It is a horseshoe magnet.

What kind of magnet do you like to use for experimenting?

Experiment with a bar magnet, a U magnet, and a horseshoe magnet. Does each magnet attract the same things? Does the shape of the magnet have anything to do with what the magnet picks up?

The shape of a magnet has nothing to do with the things it attracts.

A magnet attracts some things, but it does not attract others. A magnet attracts things made of iron or steel. Does it pick up pins? Will it pull string to it? Does it attract paper? The things picked up by your magnet are very likely made of iron or steel.

A Magnet Has Two Poles

Every magnet has two poles. The poles are at the ends of the magnet. These poles are the holding parts of the magnet.

In the picture above, three magnets are holding steel pins. Which parts of each magnet attract the most pins?

Try with your magnet the experiment which the picture shows. Does your magnet attract steel pins at the poles? Try this experiment with magnets of different shapes.

No matter what the shape of a magnet, it always has two poles. A bar magnet has a pole at each end. A U magnet is just a bar magnet which is bent. It is bent so that the two poles are near each other. In a horseshoe magnet the poles are even closer to each other.

Each pole of a magnet has a name. One is the north pole, the other the south pole. On some magnets these poles are marked.

Take two bar magnets. Hold the north pole of one magnet near the south pole of the other. Can you feel the pull? Hold the magnets closer and closer until they come together.

If the magnets are strong enough, you may hold one magnet in the air with the other. A north pole attracts a south pole, and a south pole attracts a north pole.

Now turn one magnet around. Put the north pole of one magnet near the north pole of the other magnet. Do you feel any pull? Do these two poles hold to each other?

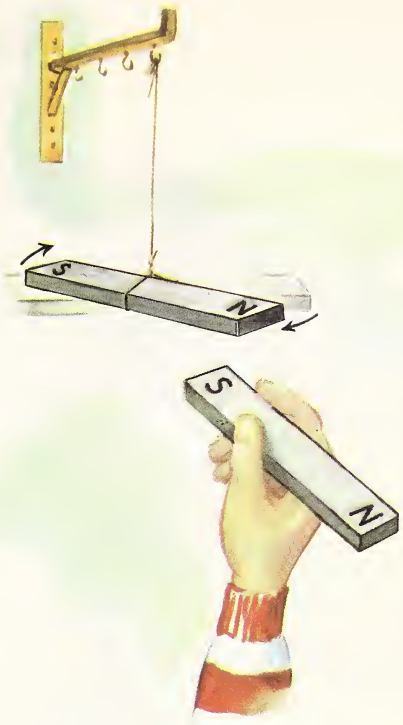
A north pole will not attract another north pole. And a south pole will not attract another south pole.

Two poles which are alike will not attract each other.

Hang up a bar magnet with a very thin string. Hold the south pole of another magnet near the north pole of the hanging magnet. Which way does the hanging magnet move?

When a south pole and a north pole are near each other like this, the hanging magnet is attracted to the magnet in your hand.

A south pole will attract a north pole. And a north pole will attract a south pole.



Now hold the bar magnet near the hanging magnet so that the two north poles are near each other. Does the magnet in your hand attract the hanging magnet or push it away?

What happens when you hold the south poles of the two magnets near each other? Two poles which are alike will not attract each other. The two magnets push each other away.

Tools That Are Magnets

Iron and steel tools may be made into magnets. When things are made into magnets, we say that they are magnetized.

Scissors may be magnetized. The cutting parts of the scissors are sometimes made into magnets. Then the magnetized scissors attract pins. The pins do not get lost so easily this way. They are attracted to the magnetized scissors.

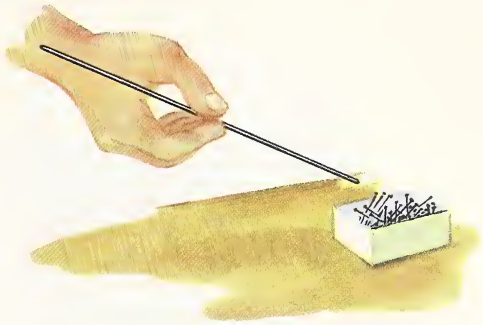
A tack hammer is another tool that may be magnetized. The iron part of the hammer is made into a magnet. It holds the tack so that you do not need to use your hand. The magnetized hammer holds the tack for you.

These tools are more useful after they are magnetized than they were before.

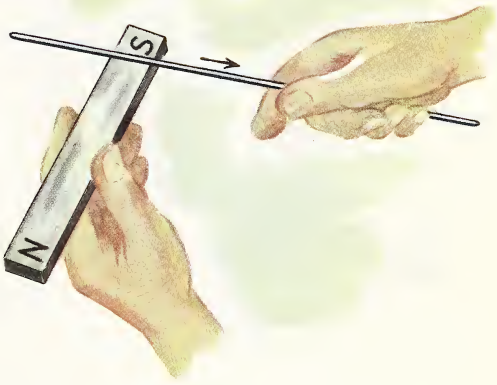
What magnetized tools have you ever used?

Making a Magnet

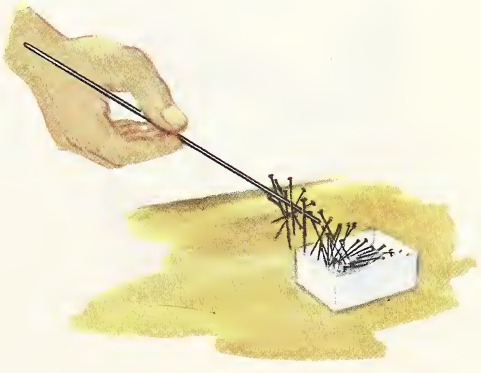
Here is the way Susan made a magnet from a steel knitting needle. First, she wanted to see that the needle was not a magnet. Then she put it into a box of steel pins. It did not attract any pins. The knitting needle was not a magnet.



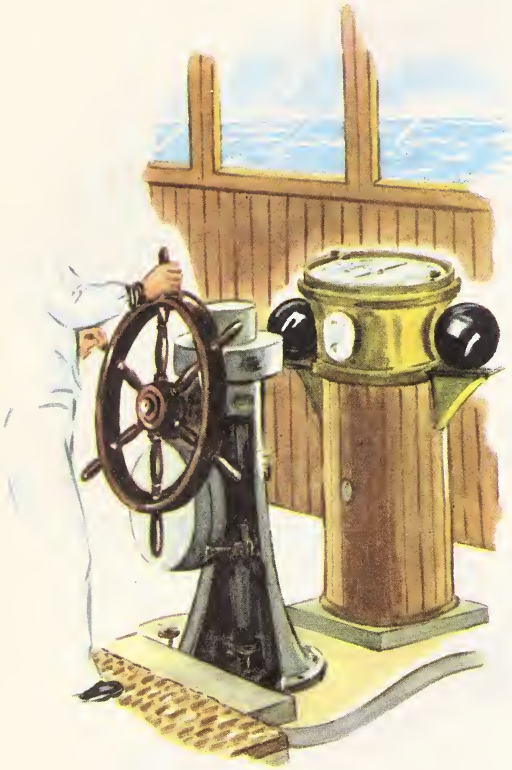
Susan held the knitting needle in one hand and a magnet in the other hand. She pulled the needle across one pole of the magnet. Each time she was careful to pull the needle across the magnet the same way. Susan did not rub the needle back and forth across the magnet. Again and again Susan pulled the needle across the magnet.



Then Susan put the knitting needle into the box of pins again. This time the needle attracted many pins. It was magnetized.



A Compass Needle Is a Magnet



Many people use compasses.

Men on ships out in the ocean can tell the directions with a compass.

The men who fly airplanes high above the clouds know their directions when they look at the compass in the airplane.

A compass is very useful. People use a compass to help them find their way. Have you ever used a compass?

Here is a picture of a small compass. On the compass there are four letters, N, S, E, and W. These letters stand for four directions.

N means north. S means south. E means east. We see the sun in the east in the morning. W means west. The sun is in the west in the late afternoon.

There is a small needle inside the compass, too. This needle moves back and forth. But if the compass is still for a while, the needle stops moving. It points toward the north.

No matter which way the compass is turned, one end of the little needle inside always points to the north. This may not always be toward the letter N on the face of the compass. You must turn the compass to bring the letter N under the point of the needle.

The little needle in the compass is really a small magnet. This magnet can move around. A compass needle moves so that one end always points to the north.

If you know where north is, it is easy to find the other directions. The needle of the compass in the picture is pointing to the north. The boy is facing north. His back is to the south. His right arm points east. And his left arm points west.

Try to find north with your compass. Then find south, east, and west as the boy did in the picture.

Here is a way to show that a compass needle is a magnet and has two poles:

Lay a compass on a table and wait until the needle stops moving. See that there are no magnets near the compass.

Then hold a bar magnet with its south pole near the end of the compass needle which points north. Is the needle attracted by the magnet?

Hold the north pole of the bar magnet near the south-pointing end of the compass needle. See how the needle swings toward the magnet.

Two different poles attract each other.

Hold the north pole of a bar magnet near the end of the compass needle which points north. Which way does the needle swing?

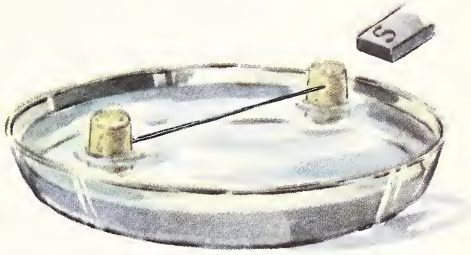
Put the south pole of the magnet near the south-pointing end of the compass needle. The needle swings away from the magnet. Two poles which are alike move away from each other.

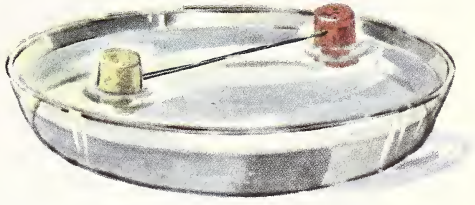
The compass needle is a magnet and has two poles.

Two Experiments for You

1. You can make a homemade compass. You magnetize a large needle first. Then stick a very small cork on each end of the needle. Float the needle and corks in a glass dish of water.

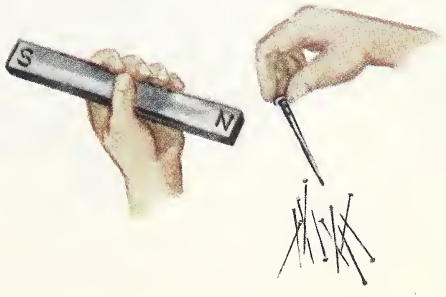
Now use a magnet to find the north- and south-pointing ends of the needle. The north-pointing end of the needle can be marked by painting the cork at that end.





2. You can make a nail act like a magnet by just holding it with a magnet. As you hold the nail with the magnet, put the nail into a pile of pins. It acts as a magnet.

Now take the magnet away from the nail. What happens to the pins? The nail acts as a magnet only while the magnet is holding it. When the magnet is taken away, the nail does not attract the pins. It no longer acts like a magnet.



Using Electricity

Experimenting with a Dry Cell

Jack and Jerry are going to put a light in Jean's dollhouse. They have a dry cell, two pieces of wire, and a little light bulb in a small socket.

"I can make the bulb light," said Jack.

Jack took the dry cell, one wire, and the light bulb. The picture shows how he hooked them together. Do you think the bulb will light? Tell why.

"The bulb does not light," Jean said.

"You can see why," said Jerry. "Electricity must get from the dry cell to the light bulb and back to the dry cell again. It cannot do this on the pathway you made. You need the other piece of wire in your electric pathway."

Can you find the place where the other piece of wire should go so that the bulb will light?

Jerry took the other wire.

"You must make a complete pathway for the electricity. To do this, you need two wires," he said. "I will hook this end of the wire under the outside screw on the dry cell. Then I will hook the other end to the screw on the light socket. Do you see why two wires are needed to make a complete pathway?"

"Yes," said Jack. "The dry cell has two screws. My wire is hooked to just the middle one. Your wire is hooked to the outside one."

"The two screws are the binding posts," said Jerry. "A dry cell has two binding posts. We have hooked a wire to each one."

"The bulb lights!" said Jean. "The wires, a dry cell, and a light bulb have made a pathway for electricity."

In the picture show with your finger the complete pathway along which the electricity travels.

Turn It Off—Turn It On

The little light burned brightly.

"How can I turn off the light?" asked Jean.

"That's easy," said Jack. "Just take the bulb out. Then the electricity does not reach the bulb to light it."

"You can take a wire from a binding post or from the light socket," said Jerry. "Then the electricity cannot get from the dry cell to the light bulb."

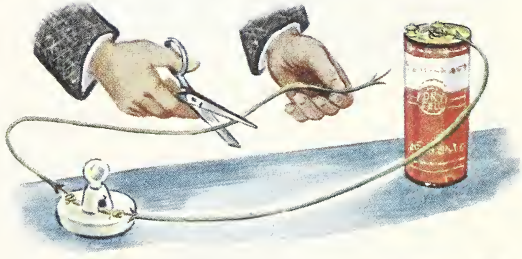
Just then Father came in.

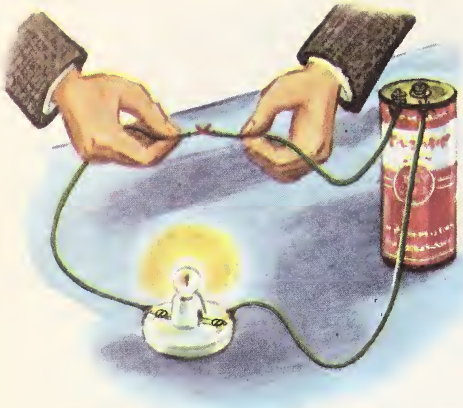
"I know another way to keep electricity from getting to the light bulb," he said. "Only one wire is hooked. I will cut the wire that is not hooked."

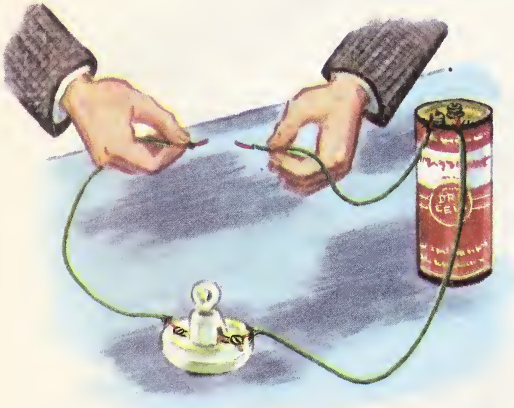
Father cut the wire.

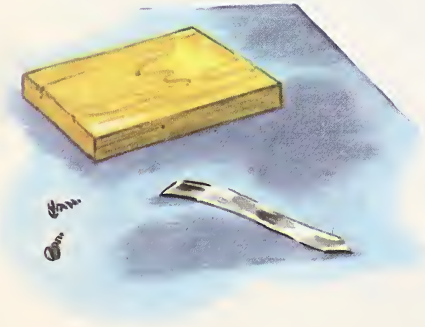
Then he hooked the end of this wire to the dry cell. Still the light did not go on. Father had cut the wire.

"Now I will show you how to make the light go on again," said Father.









Then Father held the two ends of the cut wire together. The light came on again.

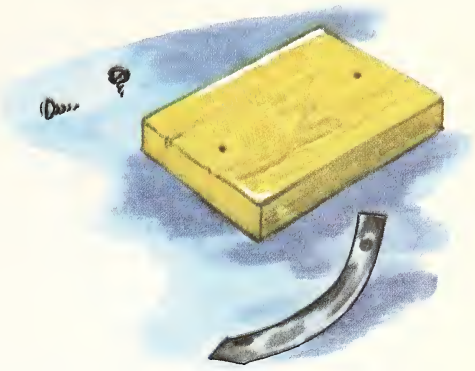
" You see you must hold the wires together to make the light come on," Father said. " When the wires do not come together, the light goes off. The pathway is not complete when the wires do not come together."

Then Father said, "A better way to turn the light off and on is to use a switch. When you use a switch, you do not need to hold the wires together."

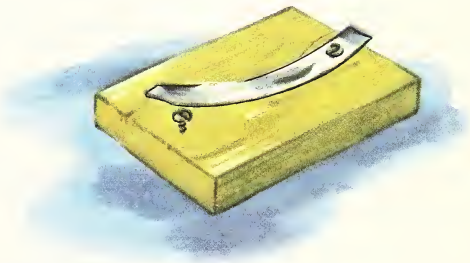
" A switch works the same way for this little light as it does for the lights in the house. We can make a switch right here for this light. We shall need a small block of wood, two screws, and a piece of tin cut from a tin can."

Father made a list on a piece of paper. Jack and Jerry took the list. Soon they were back with the things Father needed to make the switch.

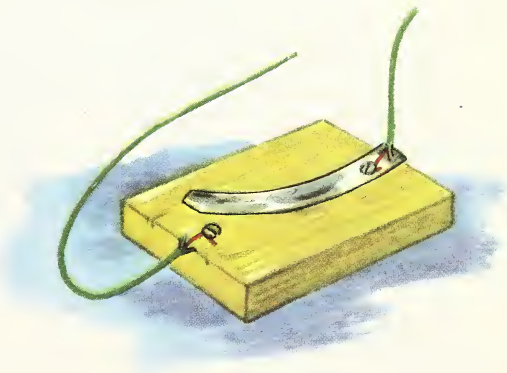
Father made two holes in the block of wood, one near each end. He made a hole in one end of the piece of tin can. Then he bent the piece of tin can a little.



Next he fastened the piece of tin can to the wooden block with a screw. He put the screw into one of the holes in the block. Then he put a second screw into the hole at the other end of the block.



Father took the two ends of the cut wire. He hooked one end under the second screw. He hooked the other end under the first screw, between that screw and the piece of tin can.



"The switch doesn't work," said Jean. "The light did not go on."

"Is the pathway complete?" asked Jack.

Then Father said, "No, the pathway is not complete. The switch is open. I will close the switch. Then the pathway will be complete. The electricity can travel from the dry cell, through the wire, and through the switch, to the light bulb and back again to the dry cell. When the pathway is complete, the bulb lights.

"With a switch you can make a complete pathway for electricity. Or you can break the pathway. Then the electricity stops at the switch.

"Open the switch. Off goes the light!

"Close the switch. On comes the light! A switch is useful in an electric pathway."

Be Safe with Switches

Did you ever stop to think how useful switches are? You use them many times each day, often without thinking about it. You can turn a switch and use electricity when you need it. A switch makes it safe for you to use electricity.

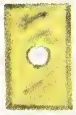
You turn on lights with a switch.

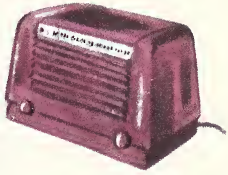
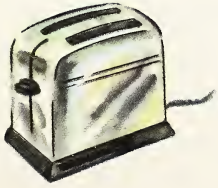
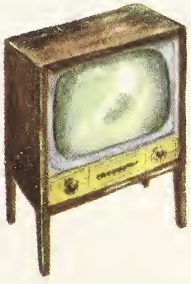
You turn on the radio and the television set with a switch.

You use switches to turn on the vacuum cleaner, the electric iron, the electric toaster, the electric stove, and other things about the house.

When someone rings your doorbell, he is using a switch.

How many, many places switches are used!



When you do not need to use electricity, you can turn it off. The safe way to turn off electricity is to use a switch.

How noisy it would be if you could not turn electricity off, as well as on! The radio would play all the time. The vacuum cleaner would buzz without stopping. The television set would stay on. The doorbell would keep on ringing.

Your house would not be safe without switches. The electric iron would become hotter and hotter. All the lights in the house would get hot, too. They would be on day and night. Your toast would burn up in the toaster. The electric stove would be too hot to use, and there would be great danger of a fire.

With switches your home is a safe place.

You can turn off the lights with a switch.

You can turn off the radio with a switch.

With switches you can turn off the television set, the radio, the vacuum cleaner, the iron, the toaster, and the stove.

Switches make it safe for you to use electricity.

Something to Find Out

1. Make large pictures of some of the things that you turn on with a switch.

2. Write a list of all the switches you use in your home. Find out how many switches Mother uses.

3. Make a complete pathway for electricity with a dry cell, wires, and a light. Then cut the wire as if you were going to put a switch in the pathway. Put different things across the break in the pathway.

Try such things as scissors, string, a paper clip, and anything else you wish. When the pathway is complete, the bulb will light. What things make a good pathway for electricity ?

4. You can make some large pictures to show where electricity travels. Make one picture to show how electricity travels with a dry cell, wires, and a light. Make a second picture to show how electricity travels with a dry cell, wires, a light, and a switch.

The Air Around You

Living in an Ocean of Air

You may be surprised to know that you are living at the bottom of an ocean! It is not an ocean of water. It is an ocean of air. This air ocean is all around the earth. It is a part of the earth.

This air ocean is much, much deeper than the oceans of water. Some scientists say that there is some air as high above the earth as five hundred miles. Think of an ocean of air five hundred miles deep! And you are living on the bottom of that ocean of air.

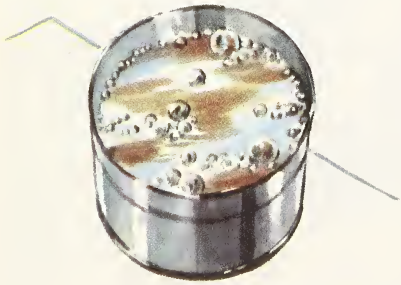
Air is all around you. Air gets into your eyes and ears. When you open your mouth to eat, air goes in with the food. You breathe air all the time. You walk through air whenever you move. There is air around you everywhere. You need air to live. Your body is made for a life in the air.

Air in Many Places

There is air in soil. The little spaces between tiny pieces of rocks and twigs in soil are filled with air. You can find out about the air in soil by trying this experiment:

Put some dry garden soil into a tin can or jar. Then pour water on the soil. The first and second pictures will show you what to do.

In the last picture you can see air bubbles floating on the water.



When you pour water on the soil, the spaces fill with water. The air that was in these spaces is pushed out. Then you see the air come to the top of the water as bubbles.

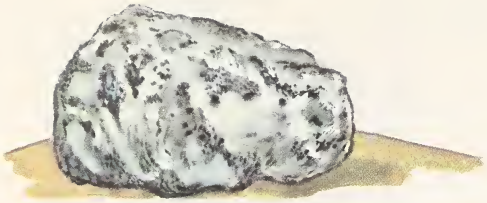
Sometimes the water does not go into the soil quickly. Can you think why this might happen? Remember that there is air in the soil. The water cannot get in until the air comes out.

There is air in water. Did you know there is space in water for air? Here is a way to see that air comes out of water:

Put some water in a pan. Set the pan on a stove and then turn on the heat. Watch to see what happens.

As the water gets warm you can see bubbles in the water. The water gets warmer. There are more and more bubbles on the sides and bottom of the pan. A bubble comes to the top of the water and breaks. Another comes to the top, and another. Air is coming out of the water in these bubbles.

The air in water is used by plants and animals which live in water. Fish breathe the air in water. Fish could not live in water if it had no air in it for them to breathe. Water plants use the air in water as they grow.



Did you know that there is air even in some rocks? Pumice is a rock with air in it. Pumice is a light rock. There are many holes in a piece of pumice. What do you think is in these holes?

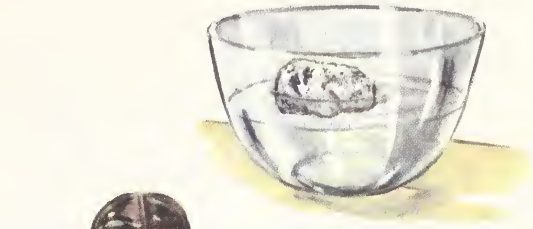
When you hold a piece of pumice under water, many bubbles come to the top of the water from the rock. They are air bubbles. As the water goes into the holes in the pumice, the air comes out.

A sponge has air in it. Hold a sponge down in a pan of water. Watch the bubbles come out of it. Squeeze the sponge. Squeeze it while it is under the water. What is in the bubbles that come out of the sponge as you squeeze it?

Air fills many spaces all about us. Air fills the spaces in soil and it fills the spaces in water. It fills the spaces in some rocks and in sponges. Can you think of other spaces that air fills? There is air in many spaces.

Air Makes Things Float

There is enough air in some rocks to make them float. The air in a piece of pumice will make it float.



A sponge has air in it. Put a sponge in a dish of water. Will it float? How long?

As long as air fills the spaces in a sponge, it will float. As some of the air comes out and the water goes into the spaces, the sponge sinks lower in the water. Will the sponge sink to the bottom of the dish? Can you tell why?

Place a balloon in a dish of water as the boy in the picture is doing. Does the balloon float?

Now blow up the balloon and close the opening. Then put the blown-up balloon in the water again. Will it float? Tell why.

The air which is in some things makes them float.

Air Is Made of Gases

The air around you is made of many gases. Your body uses some of the gases in the air. Plants use some of the gases, too. Land animals and water animals use some of the gases in the air as they live and grow.

Oxygen is one of the gases in the air. It is a very important gas. It is important because living things need oxygen. You need oxygen to live. Water animals get the oxygen they need from the air which is in the water. Many plants use oxygen as they grow.

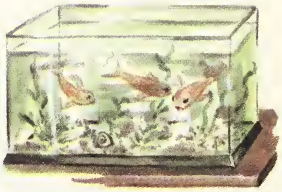
Water vapor is one of the gases in the air. When water evaporates, it changes into a gas called water vapor. The air may be filled with water vapor, but you cannot see it.

There are other gases in the air, too. You may have heard of some of them.

Water Goes into the Air

Some water is going into the air all the time. When water goes into the air, it changes into water vapor. You do not see the water vapor in the air, but it is there just the same.

Water goes into the air from the oceans and the rivers. Water evaporates from the lakes and ponds. When puddles dry up, much of that water goes into the air. Water evaporates from the soil. It evaporates from the streets and sidewalks after a rain. It evaporates from the aquarium in your schoolroom.



Water goes into the air from the leaves and stems of plants. You breathe some water into the air. When you water the garden with a sprinkler, some of the water evaporates before it reaches the ground.

Water goes into the air from many places.

Water Comes from the Air

You have read about the ways in which water goes into the air. Sometimes the air becomes so full of water that it can hold no more. Then water comes out of the air.

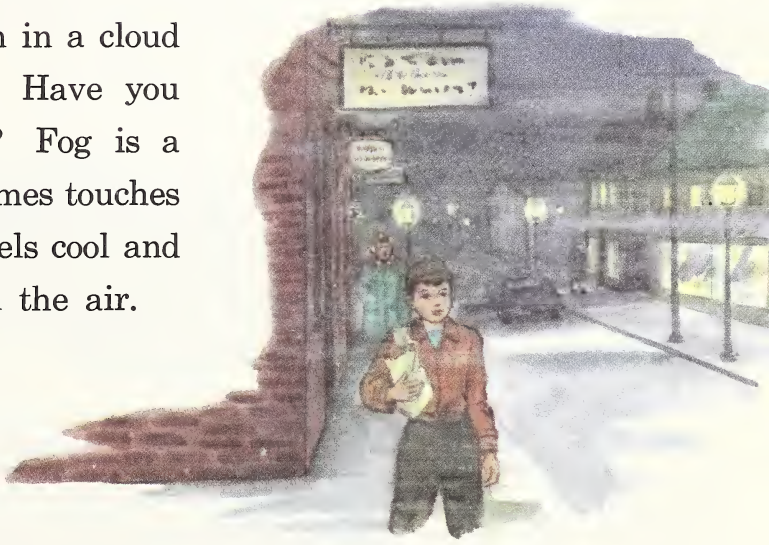
The clouds you see in the sky are water in the air. Clouds are made of many tiny drops of water. As more water goes into the air, the tiny drops start to grow.

The more water that goes into the air, the larger the drops of water become. Soon the cloud is made of big, heavy drops of water.

After a while the drops of water get so heavy that they fall from the cloud. Down, down they fall to the earth. When that happens, water comes from the air as rain.

If the air is cold enough, the water in the cloud may freeze. Then the clouds you see are snow clouds. The snow may fall to the earth. Sometimes the snow covers the ground and trees until everything looks white.

You may have been in a cloud without knowing it. Have you ever been in a fog? Fog is a low cloud that sometimes touches the earth. The fog feels cool and wet. Fog is water in the air.



You see water in the air as clouds. Water comes out of the air as fog. Water comes out of the air as rain. Water comes out of the air as snow. You can see that water comes out of the air in many ways.

Do You Remember?

Water moves into and out of the air.

Water evaporates into the air from lakes and ponds.

It goes into the air from the ground after a rain.

Some water goes into the air as you breathe.

Water comes out of the air, too.

It comes out of the air as rain or snow.

It comes out of the air as fog.

Look at the picture to find how water moves into and out of the air.

Some Things to Try

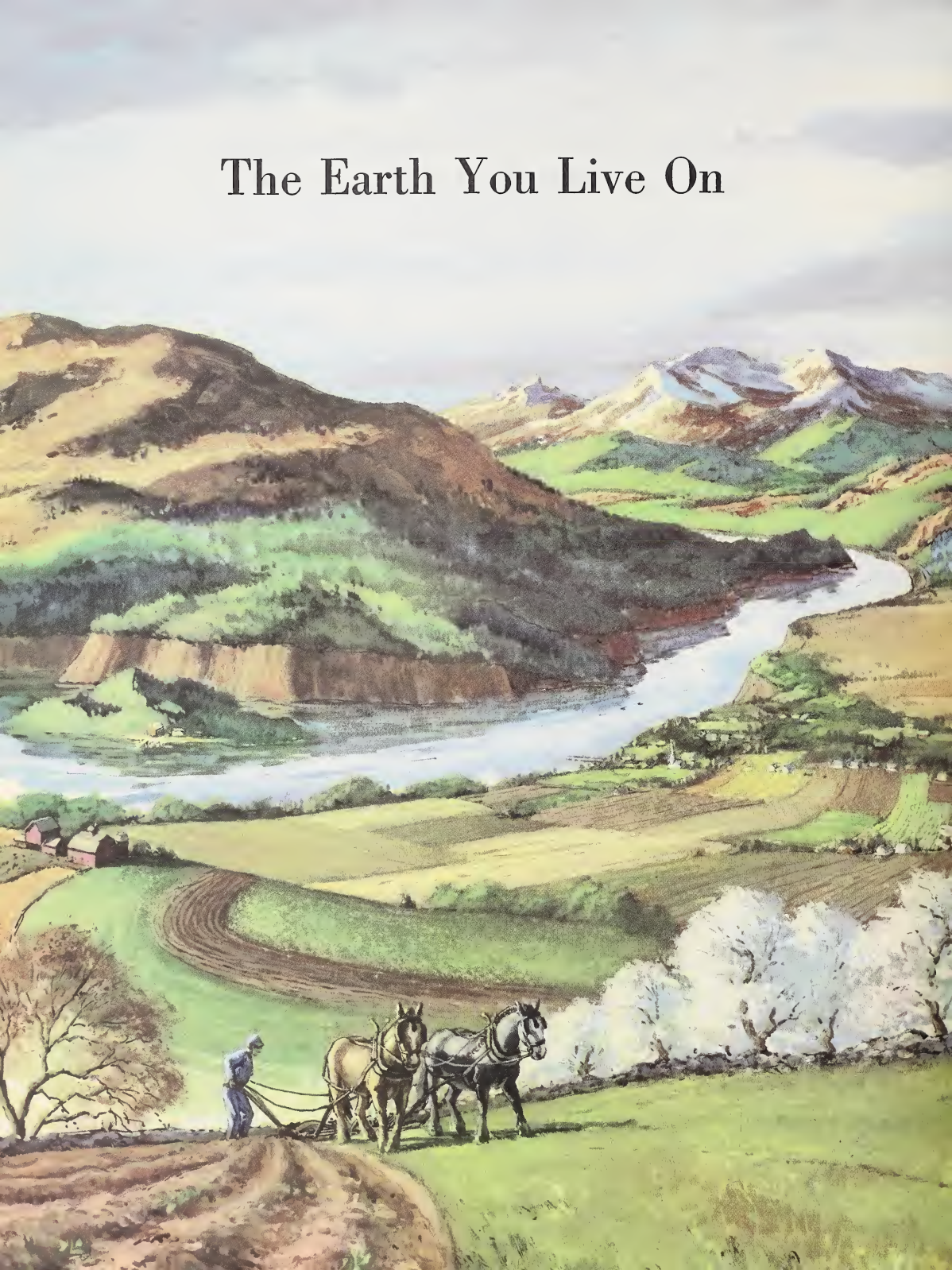
1. Set a glass of water aside on a table. Do not move it for three or four hours. Then look at it. What do you see on the inside of the glass now? The little bubbles that you see are air bubbles in the water.

2. Fill a tin cup with cold water. Put ice into the cup if you have some. Dry the outside of the cup very well. What can you see on the outside of the cup? Does the cup leak? Where did the water come from?

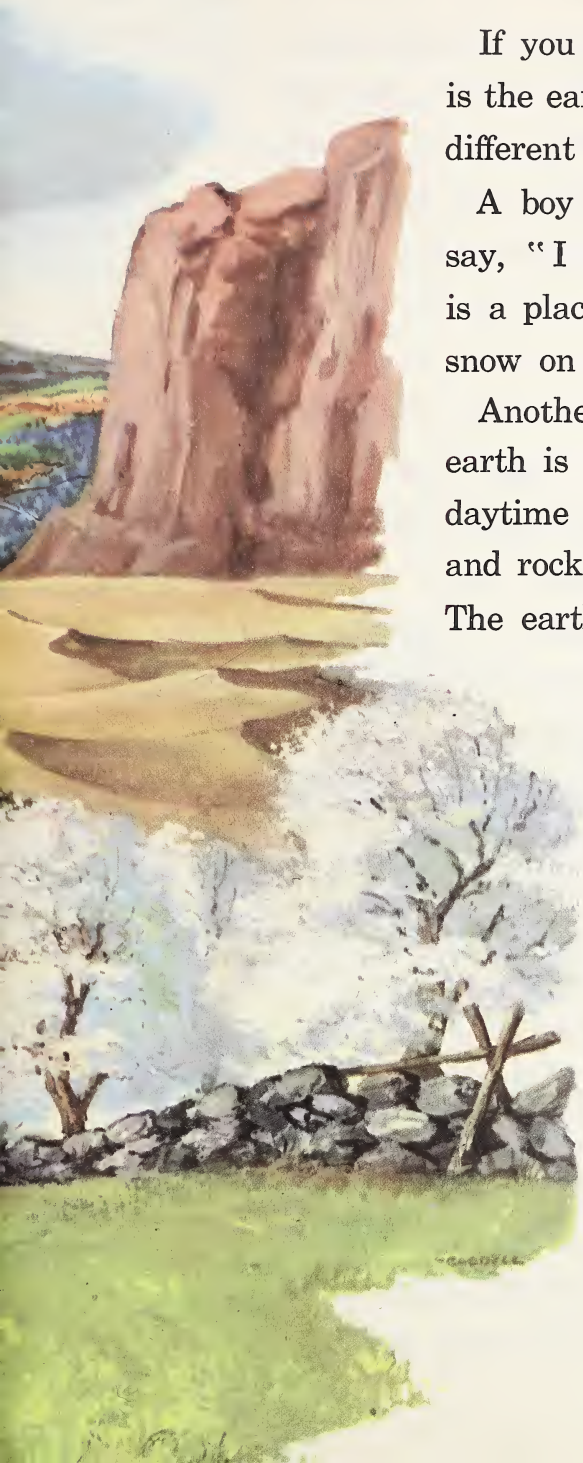
3. Put each of these things into a pan of water. Find out which ones will float. Can you tell which ones have much air in them?

a block of wood
a marble
a crayon
a sponge
a piece of pumice
a tin cup
a pebble
a paper clip
a tack
a penny

The Earth You Live On



What the Earth Is Like



If you ask other boys and girls, "What is the earth like?" they will tell you many different things.

A boy who lives in the mountains may say, "I know what the earth is like. It is a place with high mountains. There is snow on some of them all the year."

Another boy or a girl may tell you, "The earth is a big, dry place. It is hot in the daytime and cool at night. It is sandy and rocky, and there are only a few trees. The earth is like a desert."

Some children may tell you that the earth is a forest with many big trees. They may tell you of the many small green plants which grow in the cool shade of the tall trees.

Nearly every boy and girl who reads this book thinks differently about what the earth is like.

Tell what you think the earth is like.

To some girls and boys the earth may seem like many big farms with fields of corn or wheat. Still others may say that the earth seems to be miles and miles of rolling, grassy hills with no trees at all.

A girl who lives by the ocean may say, "The earth is like a long, sandy beach with rocks along it. The ocean splashes up on the beach. The waves make a loud roar and swish as they come and go on the beach."

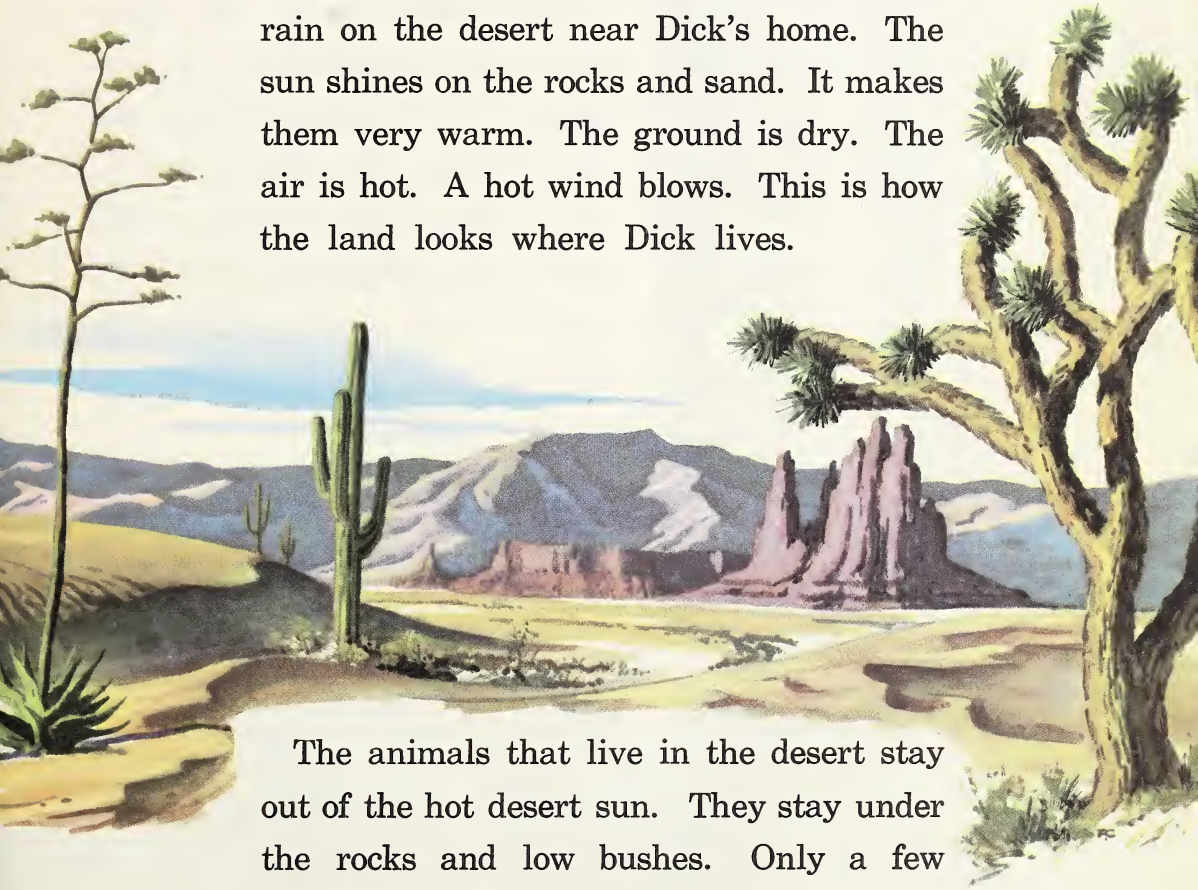
There are many parts of the earth. Hills and mountains are part of the earth. Fields and forests are part of the earth. Oceans and beaches and deserts are part of the earth.

This big, round earth is all these things.

How does the earth look where you live?

The Land You Live On

The picture below shows you how the land looks where Dick lives. His home is very near a desert. From his house near the desert he can see miles and miles of sand and bare rocks. There is very little rain on the desert near Dick's home. The sun shines on the rocks and sand. It makes them very warm. The ground is dry. The air is hot. A hot wind blows. This is how the land looks where Dick lives.



The animals that live in the desert stay out of the hot desert sun. They stay under the rocks and low bushes. Only a few kinds of plants can grow in the desert. These plants can grow with very little water.

The desert near Dick's home is a hot, dry place.

Jean's home is in a forest. All around her house there are big trees. They reach up, up for one hundred feet or more. Some of them are almost as big around as Jean's house.

The ocean is not far from Jean's home. She can hear the sound of the waves. When the wind blows from the ocean, it often brings fog with it. The fog makes everything feel very damp. The ground is damp. The air is damp.

How is the land near your home different from this?

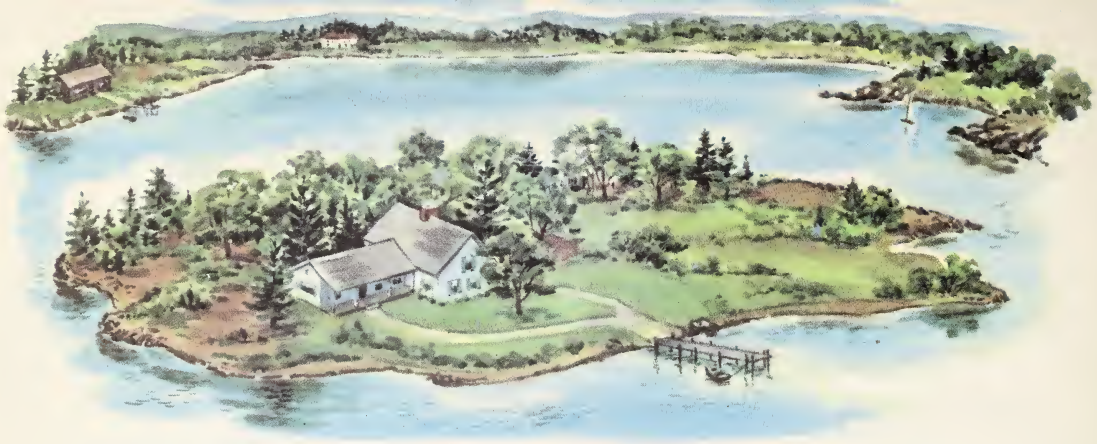
How is the land where Jean lives different from the land around Dick's home, near the desert?

Bill lives where there are many high mountains. Some of them are bare and rocky. On other mountains near his home there are forests of evergreen trees. Still others are so high that some of the snow which falls on them in the winter stays all the year.

A mountain stream runs by Bill's house. The water comes from the melting snow away up on the mountainside.

In the summer there are many wild flowers in Bill's yard. In the winter everything is covered with deep, white snow.

Is your home in the mountains? Can you find rocky hillsides and mountain streams where you live?



Ben lives on an island. Here is the way the land looks around his home. What can you see all around his home?

If Ben wanted to get off the island, how do you think he would travel? How would you get to the island to visit Ben?

Jane's home is on the plains. The rolling land goes on and on as far as you can see. The land here is covered with grasses. There are very few trees.

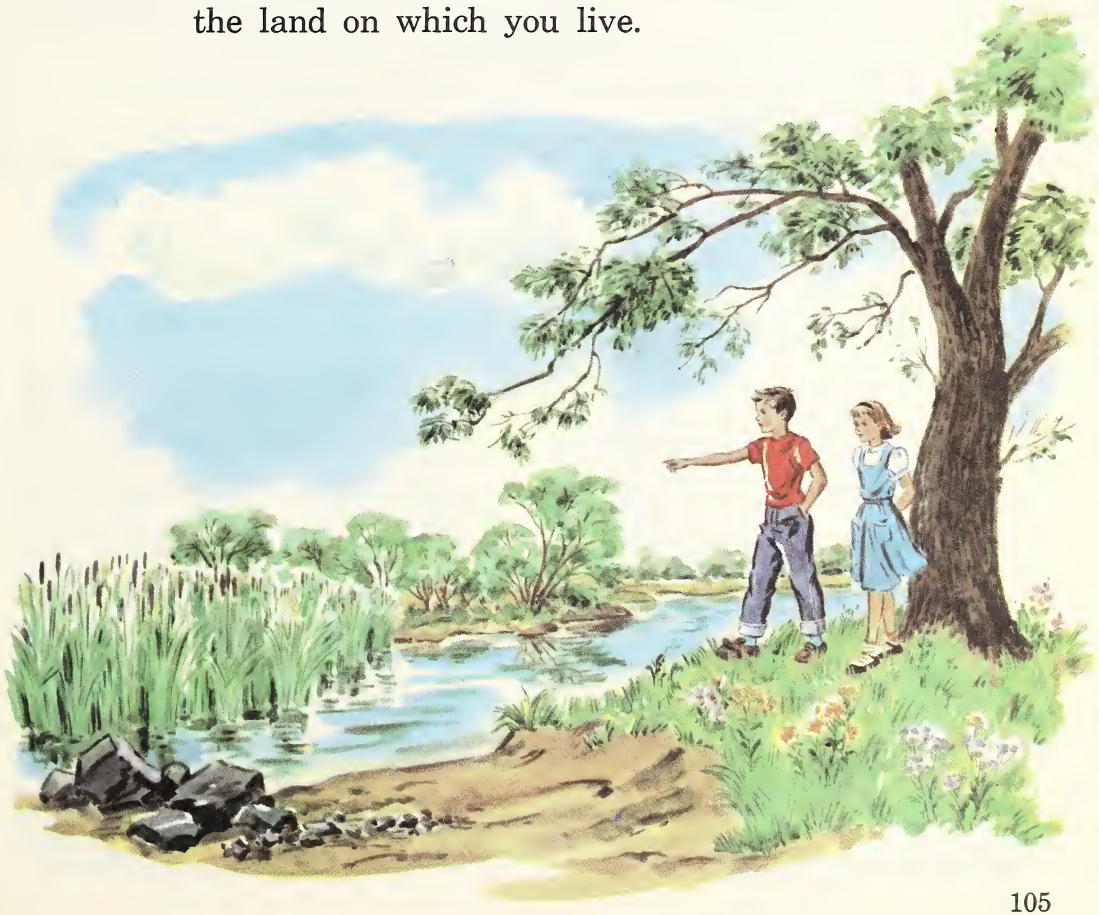
Jane's house is far from other houses. Her house is far from a town. The plains are very big. Do you know anyone who lives on the plains?

You know best about the part of the land where you live. Look at the land around your home. What is it like?

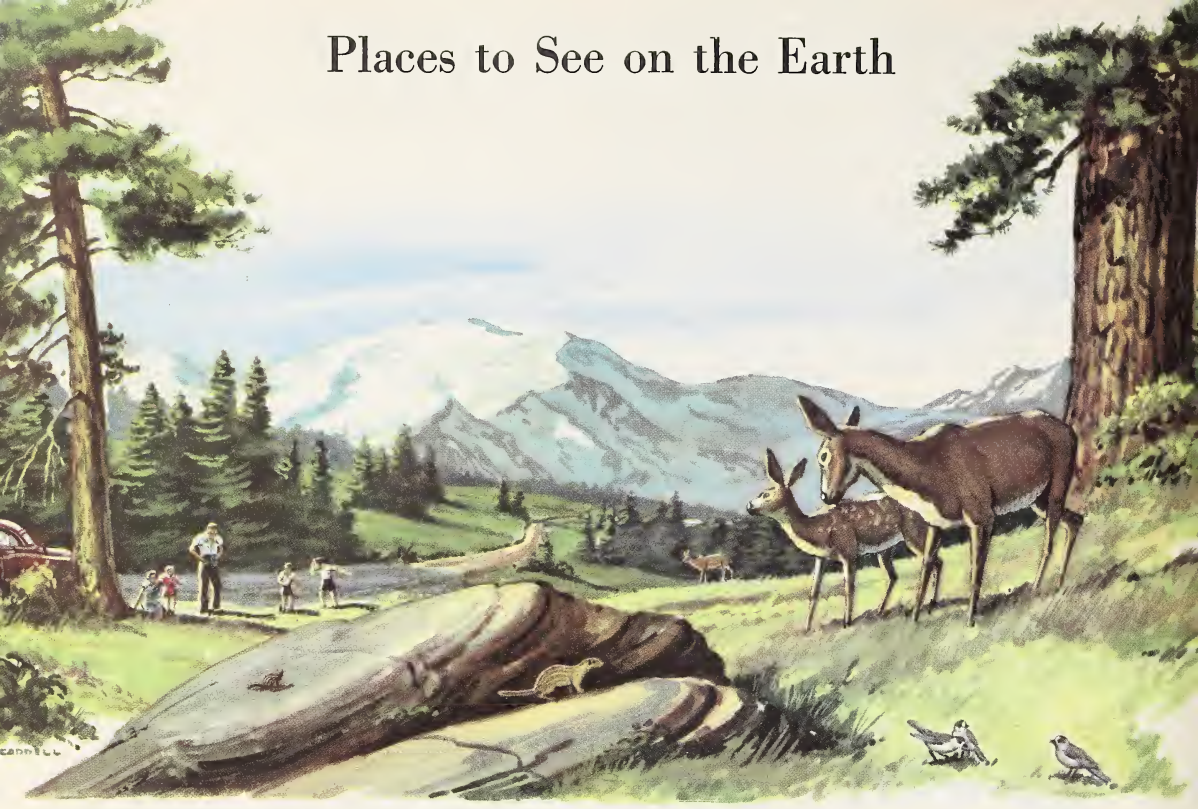
Even in your town or on your farm, not all the land looks the same. There may not be big differences, but there are likely to be some differences that you can see.

There may be high places and low places, wet places and dry places, bare rocky places, and places where many plants grow.

Try to find some of these differences in the land on which you live.



Places to See on the Earth



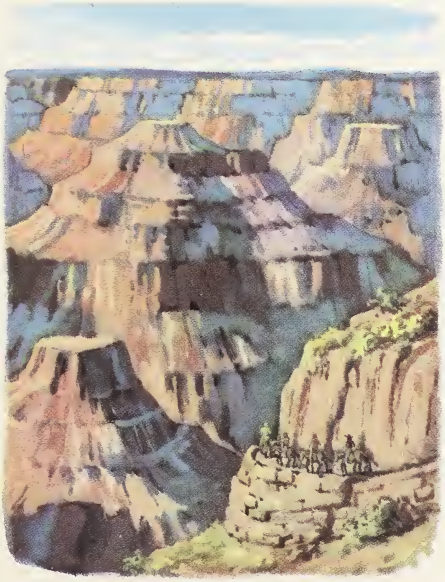
Some places on the earth are very strange and wonderful to see. Many of these places are set aside as parks. If you wish, you may visit the parks and see the different and interesting sights.

When you visit a park, you may look at all the wonderful sights. But no one takes things from a park. No one picks the flowers or the other plants which grow in the park.

In the parks there are people who will tell you about the interesting things there are to see and do. They will tell you all about the wonderful sights there are to see. They will tell you about different things in each park, such as the birds and other animals, the flowers, trees, and the waterfalls.

You may have taken a trip to a park. Your home may be near a park.

You will find all these interesting parts of the earth in parks. Have you ever seen any of these places? Do you know where any of them are?



The Big Earth

Have you ever stood on the top of a high hill or been up in a tall building?

When you are high above the earth and look about you, you feel as if you were on top of the world. You can look in every direction. The clouds sail by above you. The earth spreads out for miles around you.

You may see hills, trees, valleys, and rivers. The hills, trees, valleys, and rivers may spread out for miles all around you.

You may look far, far out over the ocean. The ocean may spread out for miles around you.

You may see animals feeding in fields. You may see farms in the valleys, or towns with houses and stores.

You may see your own house or your school.

All the things you see look small because they are far away from you. Something as big as a barn or a ship looks very small when you are far away from it.

How big the earth is! It goes on and on in every direction. You may say, "I can see the whole earth from the top of this hill." It may seem as if you could see the whole earth, but you are really looking at a very small part of it. No one has ever seen the whole earth at one time. It is much, much too big for that.

Traveling on the Big Earth

There are many places to go on this big earth. Where have you gone? What have you seen?

Have you ever been to the mountains?

Have you been to a lake?

Have you ever traveled through forests?

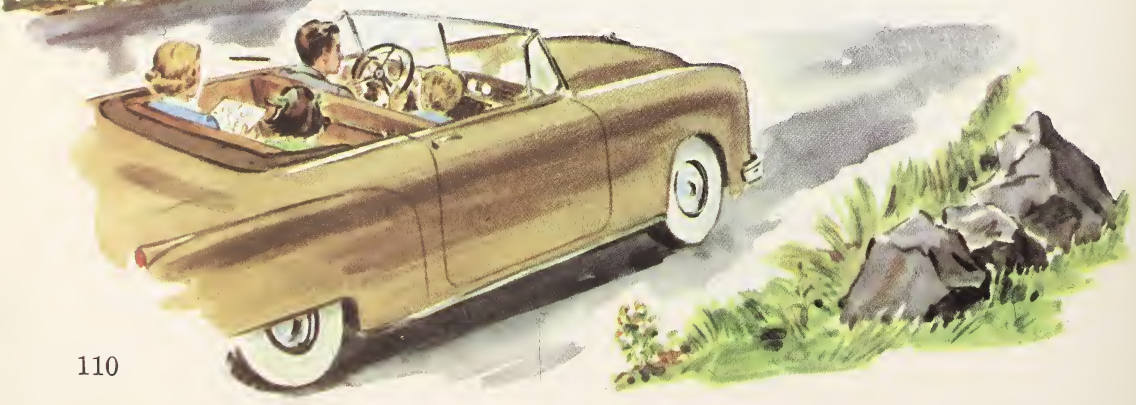
Where did your trip start? Where did it end?

Show the class your trip on a map.

There are many ways to travel on the big earth. When you travel over the solid part of the earth, you may go by car or bus or train.

Ships and boats travel on the waters of the earth.

Airplanes fly high in the air above the earth. If you want to travel very fast, you may go by airplane. An airplane travels much faster than a car or train or ship.



Do you know someone who may have been across the ocean by plane or boat? Can you find the Atlantic Ocean on the globe? Can you find the Pacific Ocean? You can fly across the oceans in an airplane, or you can travel across them in a big ship.

Do you know anyone who has been all the way around the earth? It takes a long time if you go by boat. You can go around the earth much faster in an airplane.

One way of traveling is to take make-believe trips with a globe. You may go anywhere on the earth. Take a make-believe trip across the Atlantic Ocean. Take a trip that is make-believe across the Pacific Ocean. How will you travel?

Learning More About the Earth

A globe is like a little earth. It is round like the earth. On a globe you can find the land and water parts of the earth.

You can find oceans on a globe. You can find countries on many globes. You can see how round the earth is by looking at a globe. You can learn many things about the earth from a globe.

Find the place where you live on the globe. Put a paper flag there to mark the spot. The paper flag will mark the spot where you will start your make-believe trip around the earth. You may travel north and south around the earth. Or you may go east and west around the earth.

Walk all the way around the globe on your make-believe trip. As you walk, move your finger around the globe to show where you are traveling. Go all the way around the globe and come back to the flag which marks your home.

Did your finger touch any of the blue parts of the globe? The blue parts show where there is water on the earth. Each time you touch a blue place, you are crossing water. How might you travel across the wet parts of the earth?

Did your finger touch any of the brown parts of the globe? The brown parts of this globe show the land parts of the earth. Did you cross any land on your trip? Can you name three ways to travel across the land?

On your trip around the earth, did you cross any mountains? You can use a globe to find out many interesting things about the big, round earth.

Some Things to Think About and Talk About

What differences in the land can you see from your schoolroom window?

Does the land around your house look just like the land where your best friend lives?

Is the land bare and hot and dry where you live, or is it covered with many green plants and tall trees?

Do the rocks stick out of the ground near your home or schoolhouse?

Do you go uphill or downhill to go to school?

Which do you put on more often, a big hat to keep off the hot sun or your raincoat to keep off the rain?

Do you go across water to get from your home to the city?

Where do you have your picnics — in the woods, by a lake, on a mountainside, or at the seashore?

Have you visited any parks like the ones shown in the pictures in this story? If you have, perhaps you can tell the boys and girls in your class something interesting about your trip.

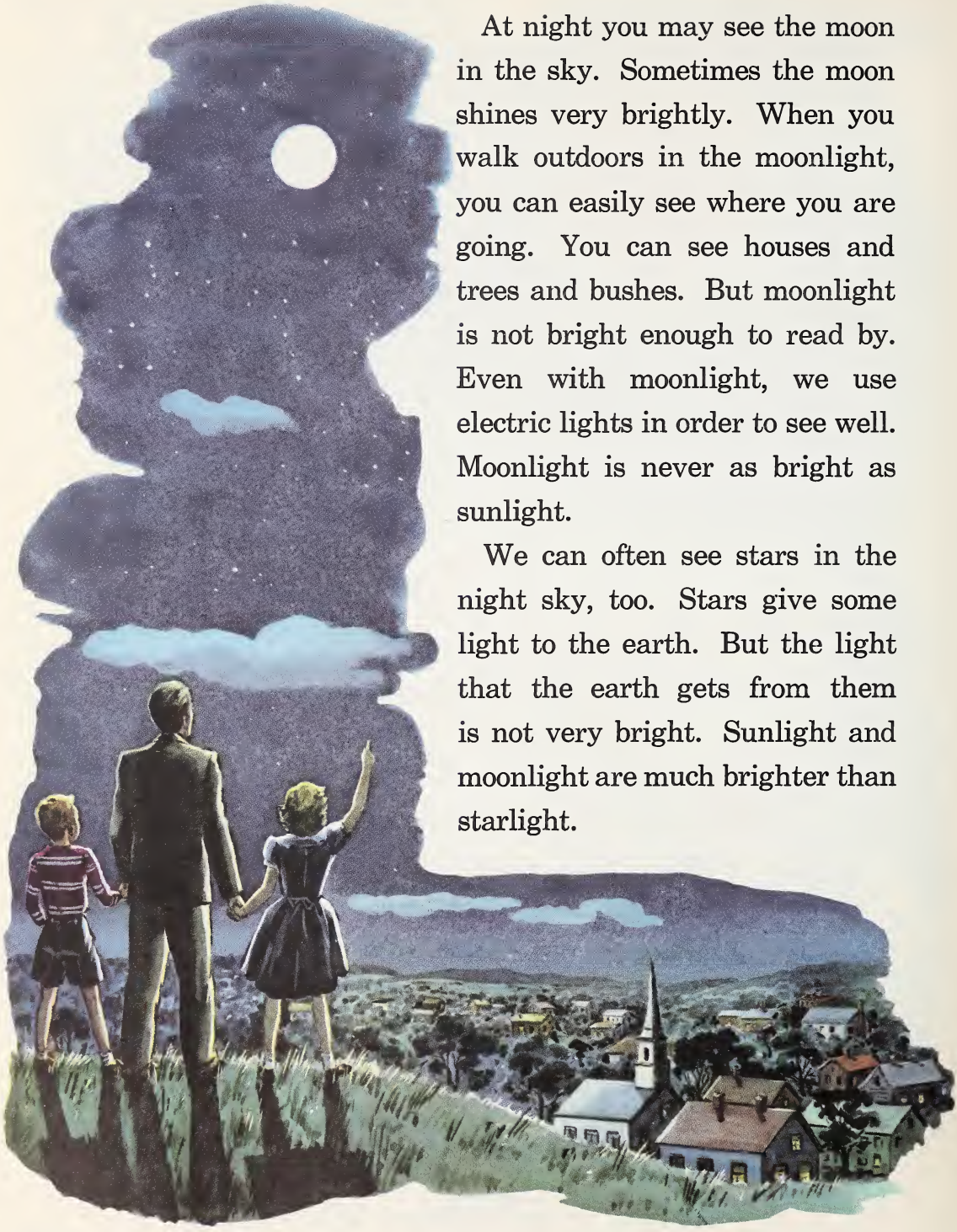
The Sky Above You

What Is in the Sky?

What can you see as you look up into the sky? If the day is clear, you may see the sun. How brightly it shines! The light from the sun makes daylight wherever it shines. The sun is so bright that you should not look right at it. So bright a light will hurt your eyes.

The sun shines brightly. It is brighter than any electric light on earth. It is brighter than many electric lights. Sunlight is brighter than moonlight. It is brighter than starlight.

Sunlight is the brightest light we know.



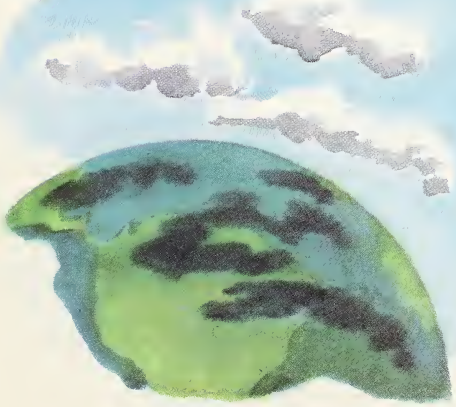
At night you may see the moon in the sky. Sometimes the moon shines very brightly. When you walk outdoors in the moonlight, you can easily see where you are going. You can see houses and trees and bushes. But moonlight is not bright enough to read by. Even with moonlight, we use electric lights in order to see well. Moonlight is never as bright as sunlight.

We can often see stars in the night sky, too. Stars give some light to the earth. But the light that the earth gets from them is not very bright. Sunlight and moonlight are much brighter than starlight.

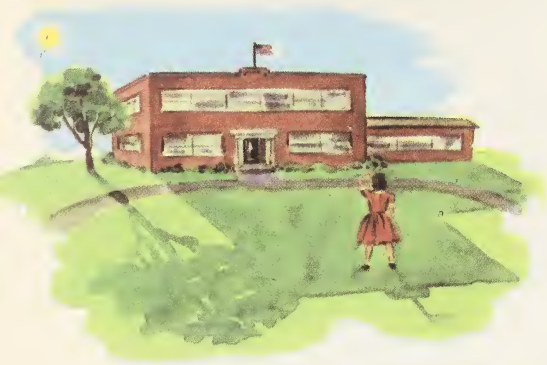
Often you may see clouds in the sky. They may be white, fluffy clouds. They may be big, dark clouds. They may be fog. On very cloudy days you may think the sun is not shining. The clouds seem to cover the whole sky. But the sun is shining high above the clouds.

As the sun shines on the clouds, they make shadows on the earth. We are in the shadows of the clouds on a cloudy day.

You may see the clouds, the stars, the moon, and the sun in the sky.



The Big, Bright Sun



The sun is the largest thing you see in the daytime sky. The sun is larger than your town. It is larger than the moon. It is larger than the earth.

The sun does not look as large as the earth or the moon, but it is. The sun looks small because it is so far, far away.

Think how small a very large airplane looks when it is high up in the air. As it flies farther and farther away, it looks smaller and smaller. Think how small a big ship seems when it is away out on the water.

The sun is bigger than any airplane or ship. But it is many, many times farther away too. The sun looks so small to us because it is far, far away.

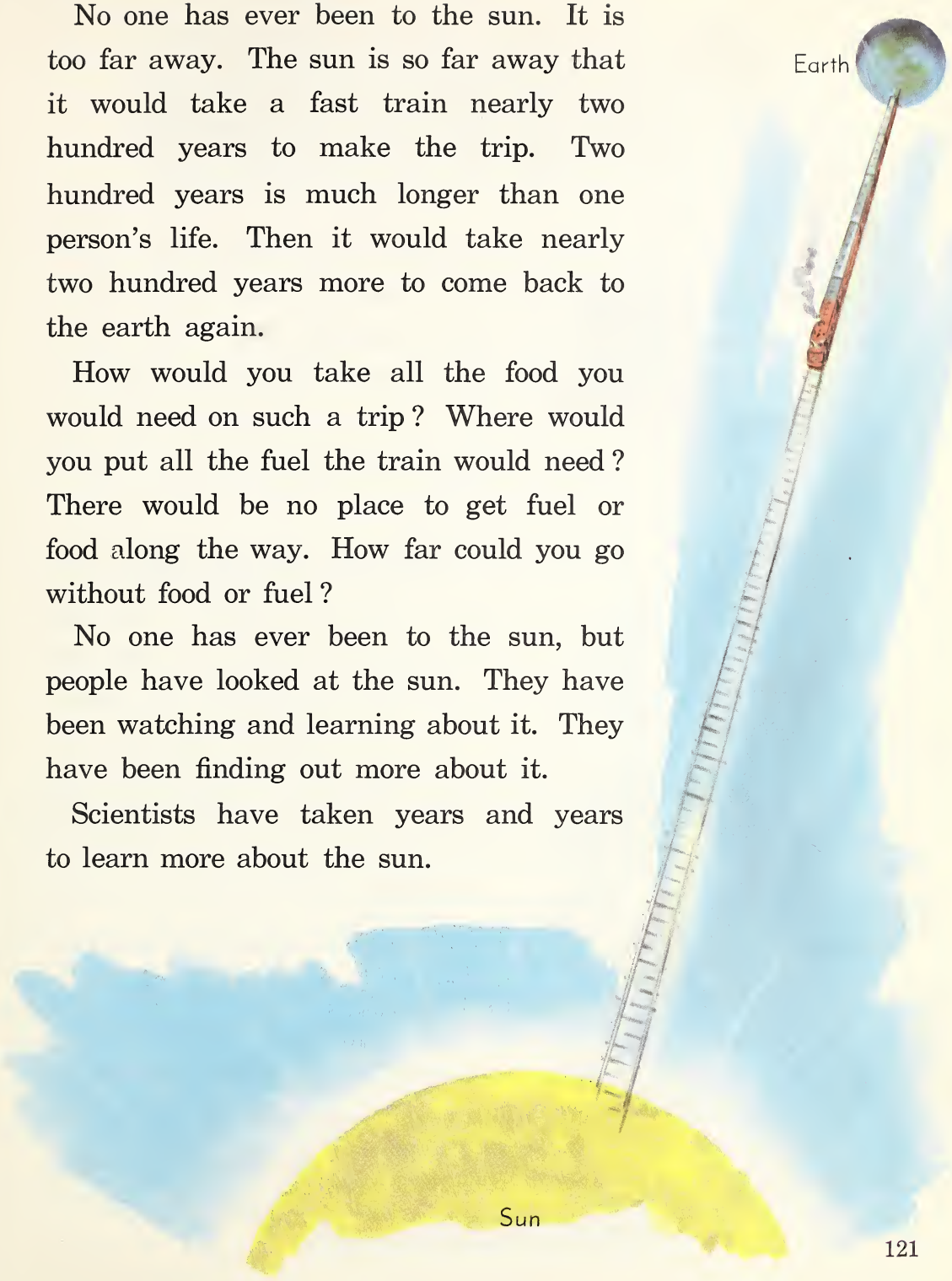
Large things look much smaller when they are far away.

No one has ever been to the sun. It is too far away. The sun is so far away that it would take a fast train nearly two hundred years to make the trip. Two hundred years is much longer than one person's life. Then it would take nearly two hundred years more to come back to the earth again.

How would you take all the food you would need on such a trip? Where would you put all the fuel the train would need? There would be no place to get fuel or food along the way. How far could you go without food or fuel?

No one has ever been to the sun, but people have looked at the sun. They have been watching and learning about it. They have been finding out more about it.

Scientists have taken years and years to learn more about the sun.



Scientists tell us that the sun is made of gases. It is not solid like the rocks of the earth. It is made of gases, like the air.

Scientists tell us that oxygen is one of the gases found in the sun. But the sun's gases are so hot that they glow. The sun is hot, but it is not burning. It glows in much the same way that the wires glow in an electric heater.

There are heat and light in the glow from the heater. The glow of the sun is greater than the glow from any heater on earth.

The sun shines with its own light. Its light comes from the hot, glowing gases of which it is made.

Sunlight is bright. It is warm. Sometimes sunlight is very hot. Some people put on dark glasses and big hats to keep the bright sun out of their eyes. When the sun is very warm, many people want to find a shady spot.

Light and heat go out from the sun in all directions. Only a very small part of all the sun's heat and light comes to the earth. But this small part of the sun's light and heat is very important to us.

Enough heat and light come to the earth from the sun to keep us warm and give us daylight. Sunlight warms the soil. It helps plants to grow.

Without this sunlight, plants and animals could not live and grow. The earth would be so cold that everything would freeze solid. The whole earth would be dark. There would be no daylight, for daylight is sunlight.

Most of the heat and light which the earth gets comes from the sun. We could not live without the sun.

Sunlight and Color

The brightest light you see on the earth comes from the sun. People sometimes use electricity to give light to the places where sunlight does not shine. Houses and towns are lighted at night by electric lights. But there is no light on the earth as bright as sunlight.

What color do you think sunlight is? Is it yellow? Is it white? Does it have any color?

There are many colors in a beam of sunlight. You can sometimes see these different colors.

Have you ever seen a rainbow? If you have, you have seen the colors in sunlight. When the sun shines through the drops of rain, the water scatters the light in the sunbeams. Then you see the colors as a rainbow.

You can often see a rainbow when the sun shines through the water from a garden sprinkler. Sometimes you may see a rainbow when sunlight shines through a corner of your aquarium. The water in the aquarium scatters the light so that you can see different colors.

A piece of glass called a prism may be used to scatter a beam of sunlight to show the colors. When sunlight shines through the sides of the prism, all the colors of the rainbow can be seen.

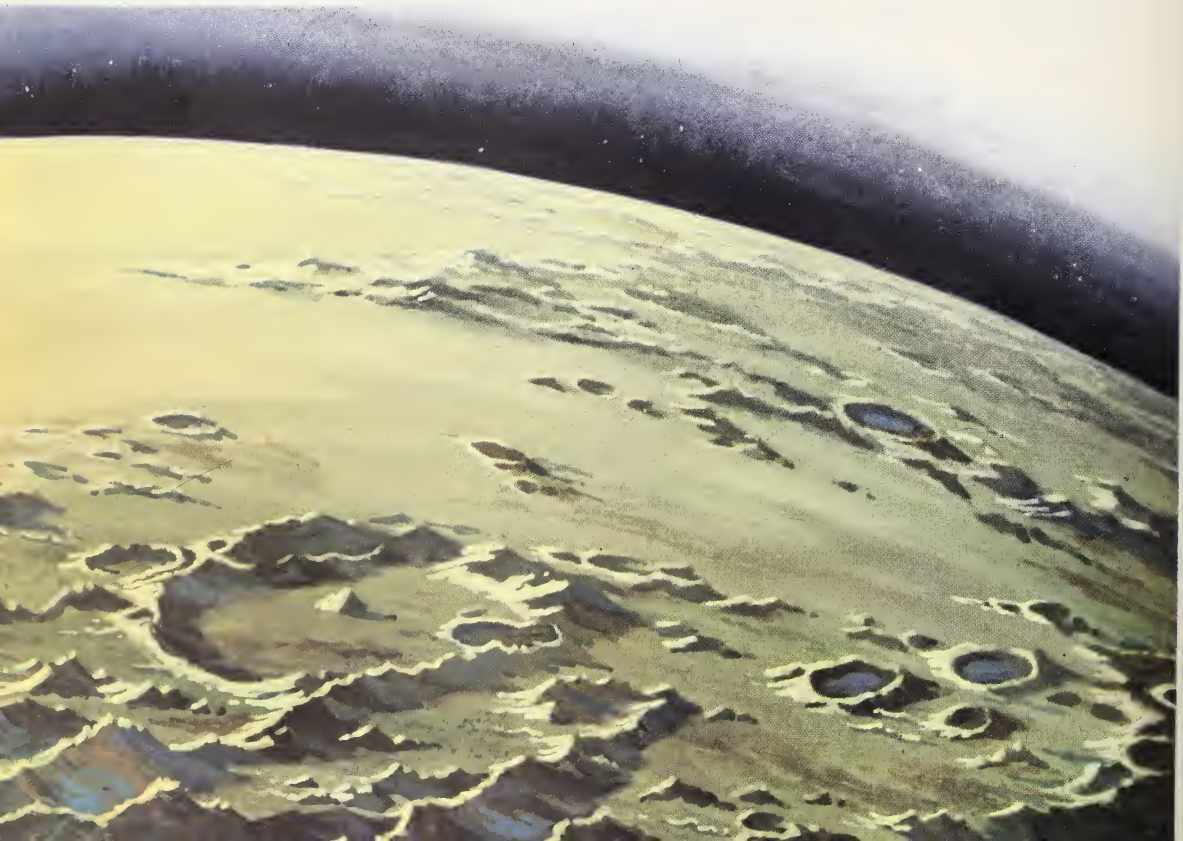
Susan is using a prism to see the colors in sunlight. If you have a prism, try this experiment.

The Moon and the Earth

The moon is much smaller than the sun. It is smaller than the earth. The moon is very much nearer the earth than the sun. It is our nearest neighbor in the sky. For this reason, scientists have found out many things about the moon.

Scientists can tell us about how the moon looks. They have taken pictures of it.

Here is a drawing that shows part of the moon. It is made from a picture taken by a scientist.

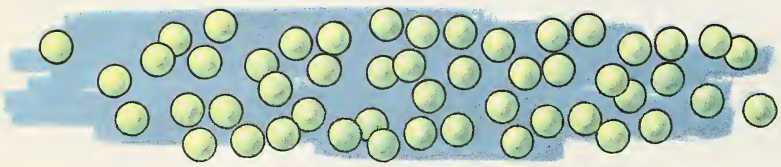


Scientists tell us that the moon is like the earth in some ways. The moon is round like the earth. It is solid just as the rocks on the earth are solid.

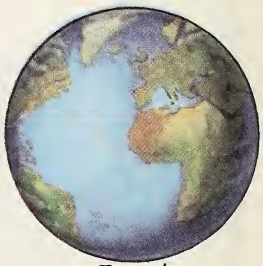
The moon gets light and heat from the sun just as the earth does. Sunlight makes day on the moon. The heat from the sun makes the rocks on the moon very, very hot.

There are mountains on the moon very much like the mountains on the earth. In the pictures above, you can see earth mountains and moon mountains. How are they the same? In what ways do they look different?

In some ways the moon is different from the earth, too. The moon is much smaller than the earth. About fifty balls the size of the moon could be put inside a ball the size of the earth.



Fifty moons could be put inside the earth



Earth

Scientists say that the moon would not be a pleasant place for us to live. The moon is very hot by day and very cold by night. You could not keep warm at night on the moon.

Some scientists say that there is little if any air on the moon. There is no great ocean of air around the moon, as there is around the earth.

Scientists say that there are no clouds on the moon. The clouds you see are in the air around the earth. They are very near the earth. Scientists say that there is no rain on the moon. There are no lakes or rivers.

On the moon there are no plants or animals such as we know.

What a bare, dry place the moon must be!

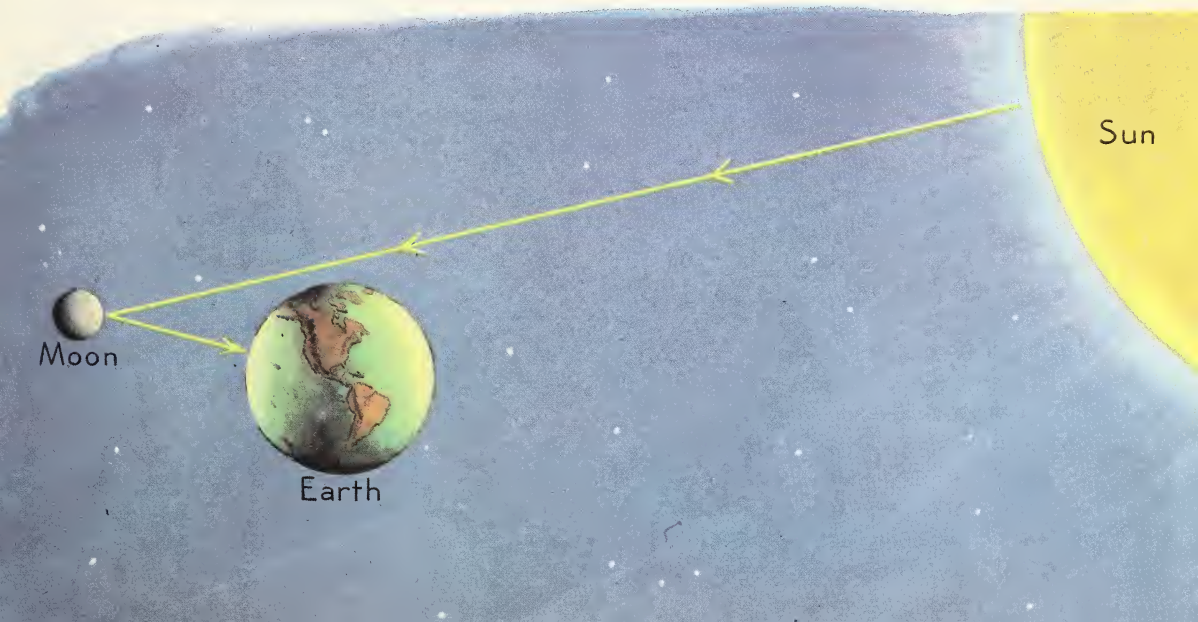
How the Moon Shines

Moonlight is very different from sunlight. Moonlight does not feel warm. It is never as bright as sunlight.

You know that the sun's light comes from the hot, glowing gases of which the sun is made. But the moon is not made of gases. The moon is solid. There are many rocks on the moon. These rocks do not glow as the sun's hot gases do.

The moon is like a round, dark globe. It has no light of its own.

"Then where does the moonlight come from?" you ask. You may be surprised to know that moonlight really comes from the sun!

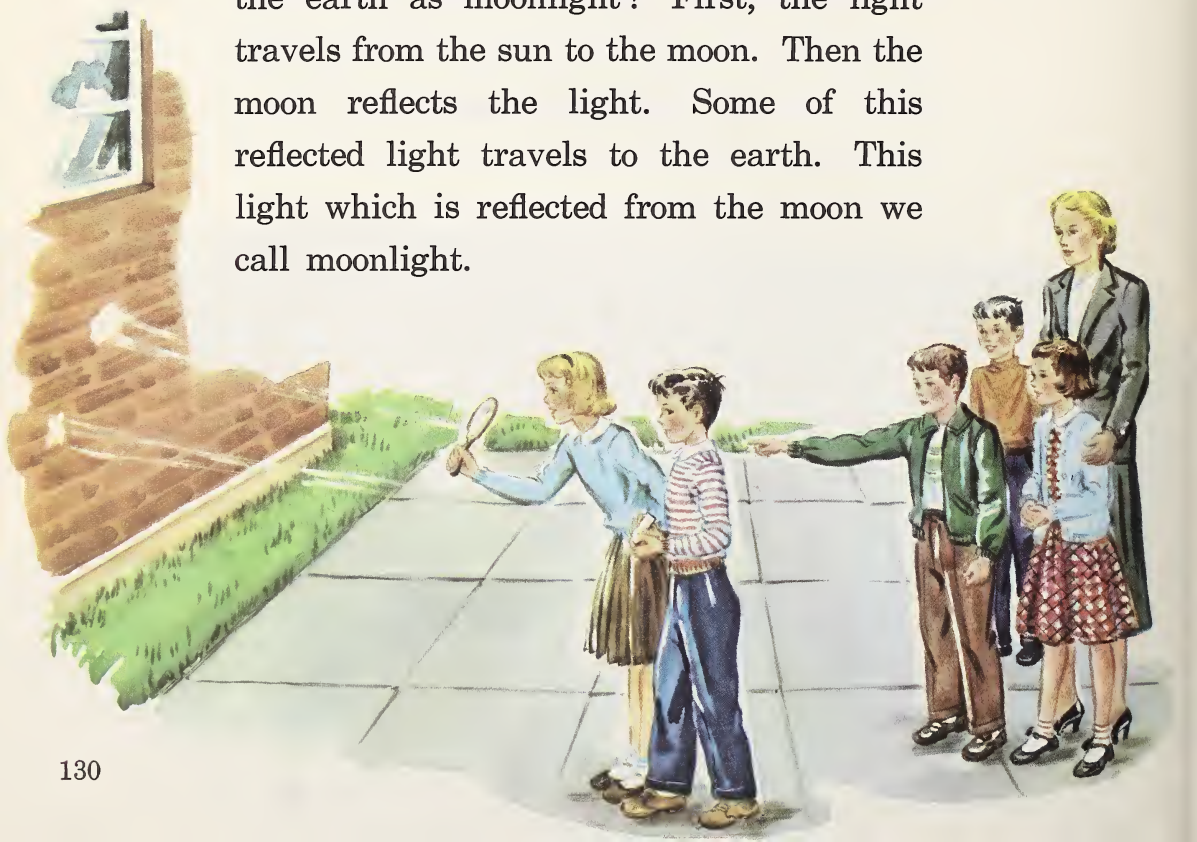


The sun shines on the moon. Then the moon reflects that light to the earth in much the same way that light is reflected from a mirror.

When you hold a mirror in the sunlight, the light strikes the mirror. Then the light is reflected off the mirror and shines somewhere else. With a mirror you can reflect a beam of sunlight.

The moon acts somewhat like a big, big mirror. It reflects some of the sunlight which it gets.

What a long way light travels to reach the earth as moonlight! First, the light travels from the sun to the moon. Then the moon reflects the light. Some of this reflected light travels to the earth. This light which is reflected from the moon we call moonlight.



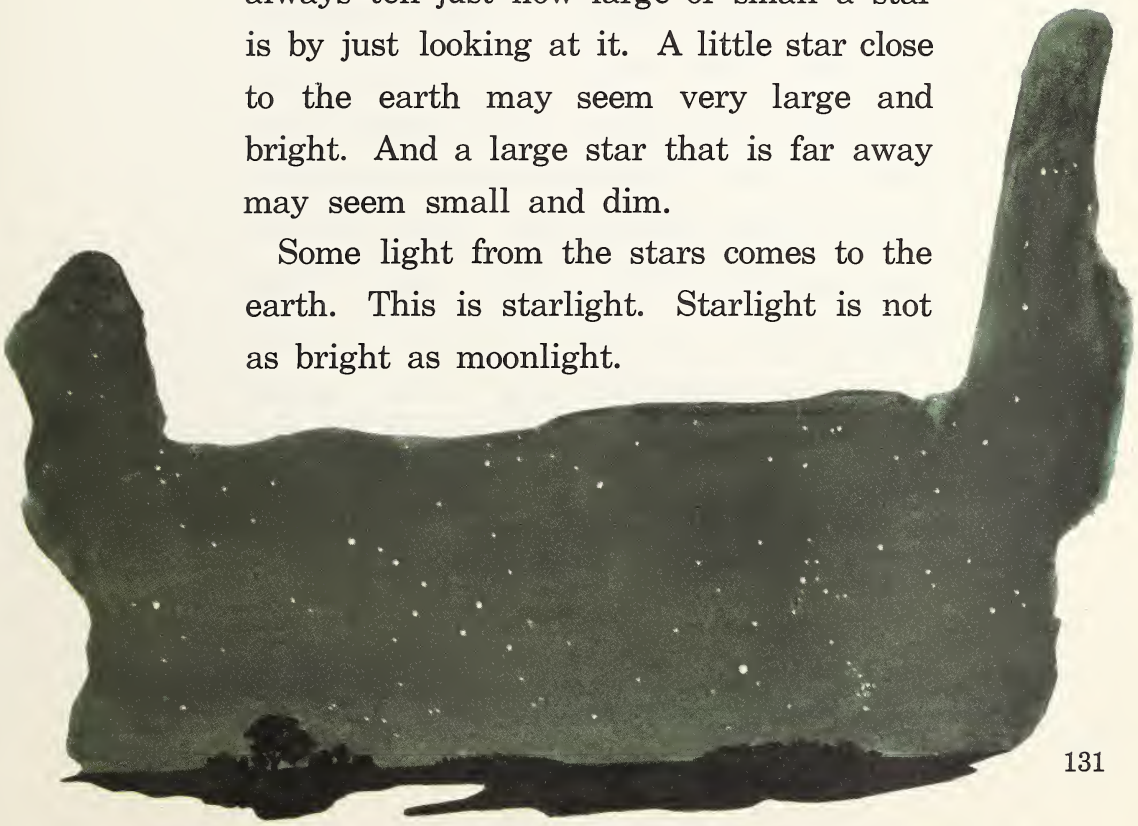
Watching the Stars

When you look into the sky on some nights, you may see many, many stars. Some stars seem very bright, and some seem dim and faraway.

How many stars are there? There are more than you can count. No one really knows just how many there are. New stars are being found all the time as scientists watch and learn about the sky.

There are big stars and little stars, bright stars and dim stars. You cannot always tell just how large or small a star is by just looking at it. A little star close to the earth may seem very large and bright. And a large star that is far away may seem small and dim.

Some light from the stars comes to the earth. This is starlight. Starlight is not as bright as moonlight.



A Game for You

Here is a game for you to play. Read each one of the things below. Try to guess what each tells about. Find out how good you are at this game.

1. I am very bright. My heat warms the earth. What am I?

2. You can see me in the sky at night. I give some light to the earth. My light is never as bright as sunlight or moonlight. What am I?

3. I am round like the earth. I am solid like parts of the earth. I have no light of my own. What am I?

4. I am very large. I am made of hot, glowing gases. My heat and light go out in all directions. Without my light and heat, nothing could live on the earth. What am I?

5. I am somewhat like a big mirror in the sky. I reflect light to the earth. What am I?

6. You can often see me in the daytime sky and in the night sky. I may be fluffy and white or big and dark. I sometimes hide the sun. What am I?

Some Things to Do

1. On a bright moonlight night stand outdoors. Look about you. Can you see things clearly? Can you see across the street or to the other side of your yard? Can you see shadows? Is there enough light to read by? Does the moonlight feel warm?

2. Make a class book of pictures of the moon.

3. On a sunny day place a thermometer in the bright sunlight. Place another thermometer in the shade. Leave them for a few minutes. Then look to see what each temperature shows. What are the two temperatures? Which thermometer shows the higher temperature? How much warmer is it in the sun than in the shade?

4. With colored paper or paints, make a rainbow to show the colors in sunlight.

5. Take a make-believe trip to the moon. Tell about all the things you would need to take with you. How would you get there, and how would you get back to earth again?

Using Water Wisely

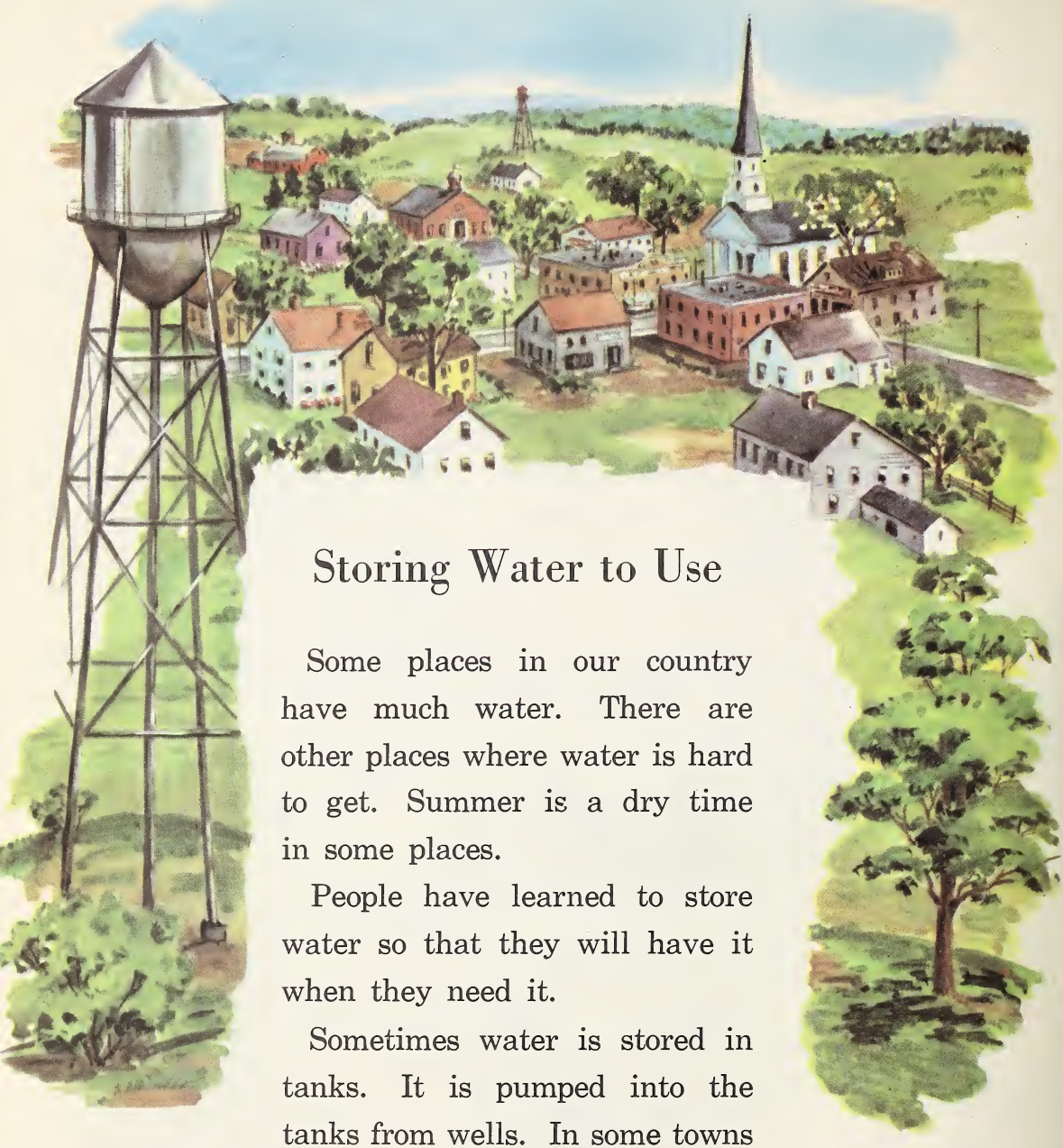
Living Things Need Water

Have you ever stopped to think how many times a day you get a drink of water?

You need water. Other living things need water, too. Cows and horses need water. Ants and other insects need water. Fish and many other animals live in water. If there were no water in the rivers and oceans, these animals could not live.

Plants need water. Trees, grass, and flowers need water in order to live and grow.

Water is important to living things.



Storing Water to Use

Some places in our country have much water. There are other places where water is hard to get. Summer is a dry time in some places.

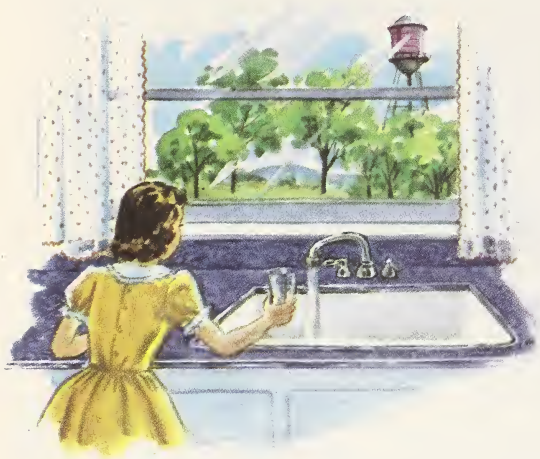
People have learned to store water so that they will have it when they need it.

Sometimes water is stored in tanks. It is pumped into the tanks from wells. In some towns there are two or three large water tanks. The water goes from the tanks to the houses in the town through pipes.

In some places water is stored in lakes. Sometimes a large dam is made across a stream. This dam holds back the water and makes a lake. The water is stored in the lake until it is needed. Is there a lake like this near your home? Is there a dam near your home?

On many farms and ranches water is stored in ponds. Animals drink the water from these ponds.

Ways to Use Water



People use water to drink and for cooking.

Firemen often use water to put out fires.

People use water for their gardens. The water keeps the gardens growing well.

Water is used to clean the streets. Water is used for many things.

Water in Sally's Town

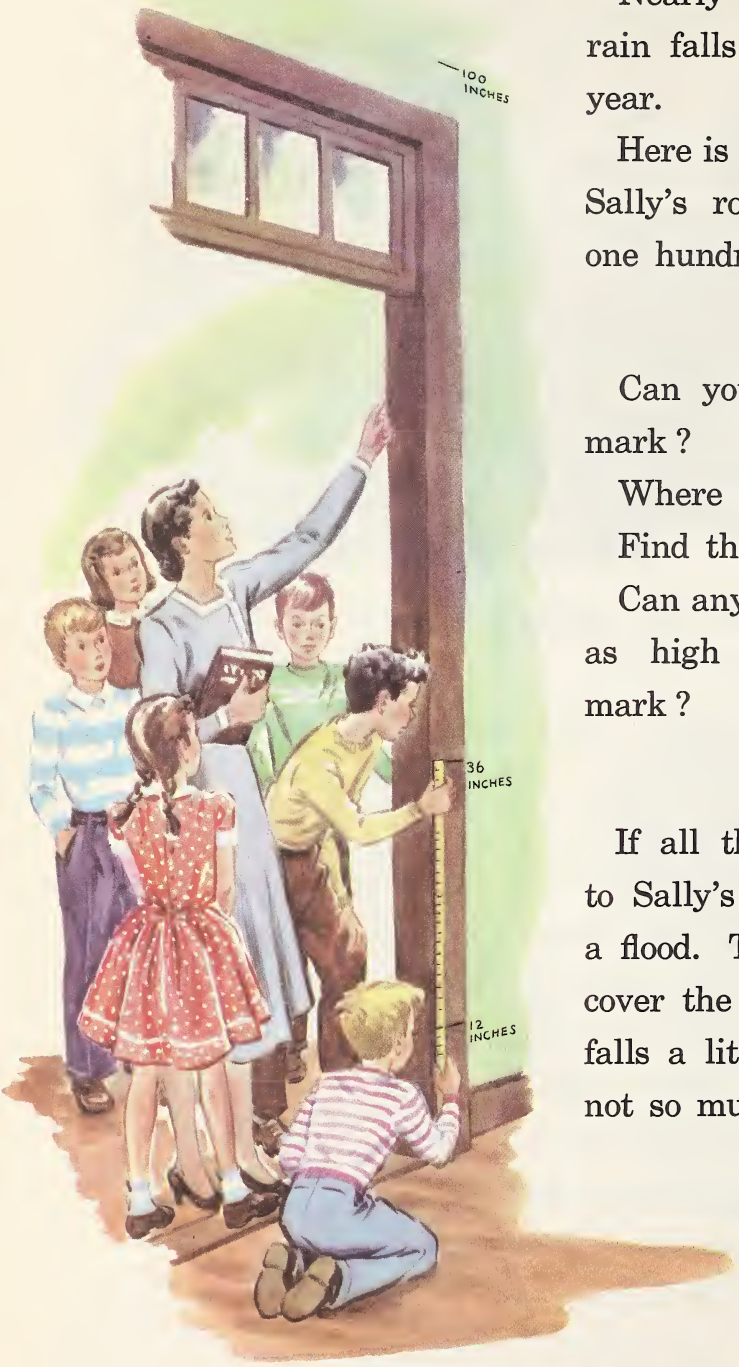
In Sally's town there is enough water for everyone to use.

Sally's father has a fine garden. Sally's mother has many flowers growing in her yard. The grass is green and soft.

Many of the trees in Sally's town are tall. They often grow along both sides of the street. In summer they help to keep the town cool and pleasant.

Where Sally lives, there is much rain in the wintertime. Sometimes the town is covered with a gray fog.

When the fog comes, it seems to cover everything.



Nearly one hundred inches of rain falls in Sally's town every year.

Here is the way the children in Sally's room at school marked one hundred inches.

Can you find the twelve-inch mark ?

Where is the next mark ?

Find the hundred-inch mark.

Can anyone in your class reach as high as the hundred-inch mark ?

If all this rain came at once to Sally's town, there might be a flood. The flood would almost cover the town. When the rain falls a little at a time, there is not so much danger of a flood.

Some rain falls on the trees, the grass, and the gardens.

Some of the rain stays in puddles on the ground for a while. Then most of this water sinks slowly into the earth.

Some of the rain falls into the ponds and rivers and oceans.

Some of the rain falls on the houses and sidewalks. Much of this water evaporates into the air again.

The people in Sally's town store water. They have enough water to drink all the year.

There is enough water in the ground to keep plants growing well.

The people in Sally's town know how good it is to have all the water they need. They use the water wisely.

Water on Paul's Farm

Paul lives on a farm where it is very dry. There is very little water near his home. There is not enough water to grow crops.

Water for the crops must be brought to the farm. The people near Paul's home use the water very carefully.

There are high mountains near Paul's home. Sometimes Paul can see rain falling in the mountains when the sun is shining at his home.

In the winter, snow falls in the high mountains. When the snow melts, it turns to water. Some of the water comes down to the farm in pipes and ditches. Then there is enough water for the crops.

Rain and snow in the mountains mean water on Paul's farm.

Look at the picture below.

Does the land on both sides of the fence look the same?

Can you tell which land gets the water? Use the picture to show what you think.

Water at the Ranch

Joe lives on a cattle ranch. There is very little water on the ranch in the summertime. The days are very warm. Very little rain falls on the ranch in the summer months. This is a dry time of the year on Joe's ranch.

Only about twelve inches of rain falls in a whole year where Joe lives. Twelve inches is not much rain for a whole year.

Can you measure to find how much twelve inches is? This is all the rain that falls at Joe's ranch in a year.

How many inches of rain falls in a year in your town? Is this more or less rain than where Joe lives?

On Joe's ranch there are some water holes. The cattle come to these water holes to drink. If there has been enough rain, the water holes are full of cool water. The grass is green. The cattle have enough to eat and cool water to drink.

Sometimes there is not enough rain. The water holes dry up. The grass turns brown. There is no cool water in the water holes. Even the mud dries up, and there is only dust.

On Joe's ranch there are some wells and windmills. When the water holes dry up, Joe's father starts the windmills. They go round and round as the wind blows. They pump and pump the water from the deep wells.

The water goes into a big tank beside each windmill. Soon the tanks are filled with clean, cool water. Then the cattle may drink from the tanks.

There is a pump in Joe's yard. Joe's family uses water from this pump to drink.

His father puts some of the water from this pump on the garden.

Joe takes his baths in this water.

Joe's mother uses water from the pump for cooking and for washing the clothes.

Joe and his family know how important water is to them. Everyone in Joe's family uses the water carefully. If Joe and his family use the water wisely, they will all have enough.

Water Where Ann Lives

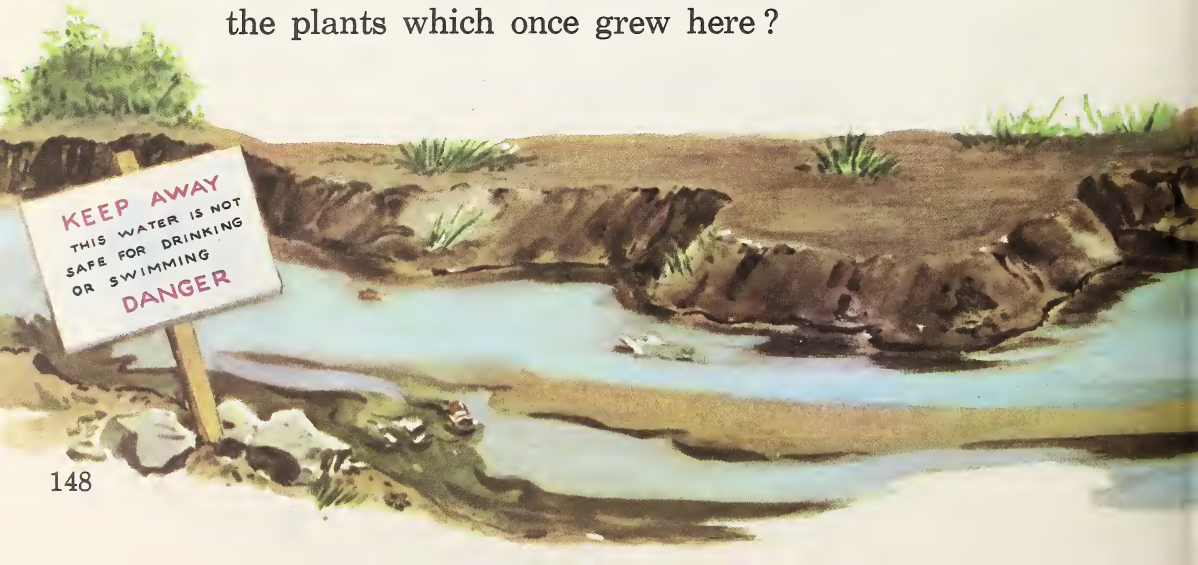
Ann lives where there are many ponds and brooks.

When Ann's mother was a little girl, she played by the brooks and the ponds. Now, if you were to visit Ann, you would see the sign below by many of the brooks.

Look at the brook in the picture. Would you like to play by this water, or sail your boat here? Do you think you would be likely to find fish here?

Most fish and snails and other water animals need clean water in which to live. Most fish and snails and other water animals cannot live well in water which is not clean.

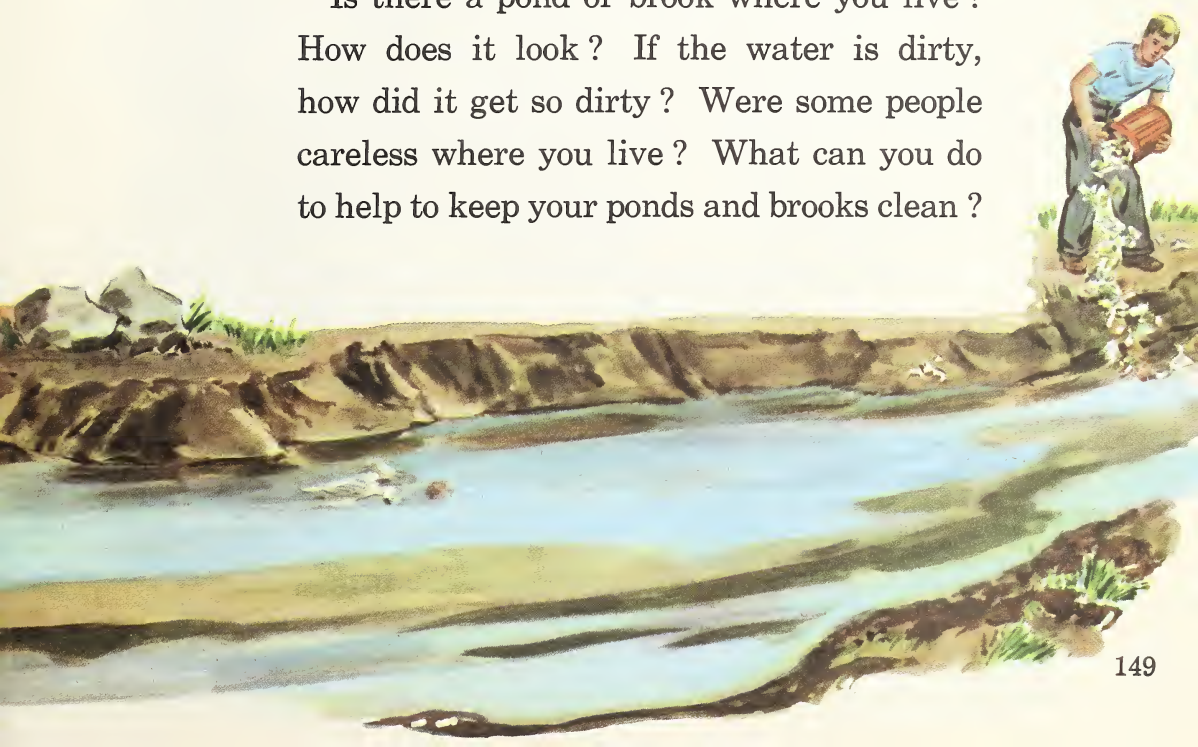
Look at the banks beside the brook. What do you think has happened to the plants which once grew here?

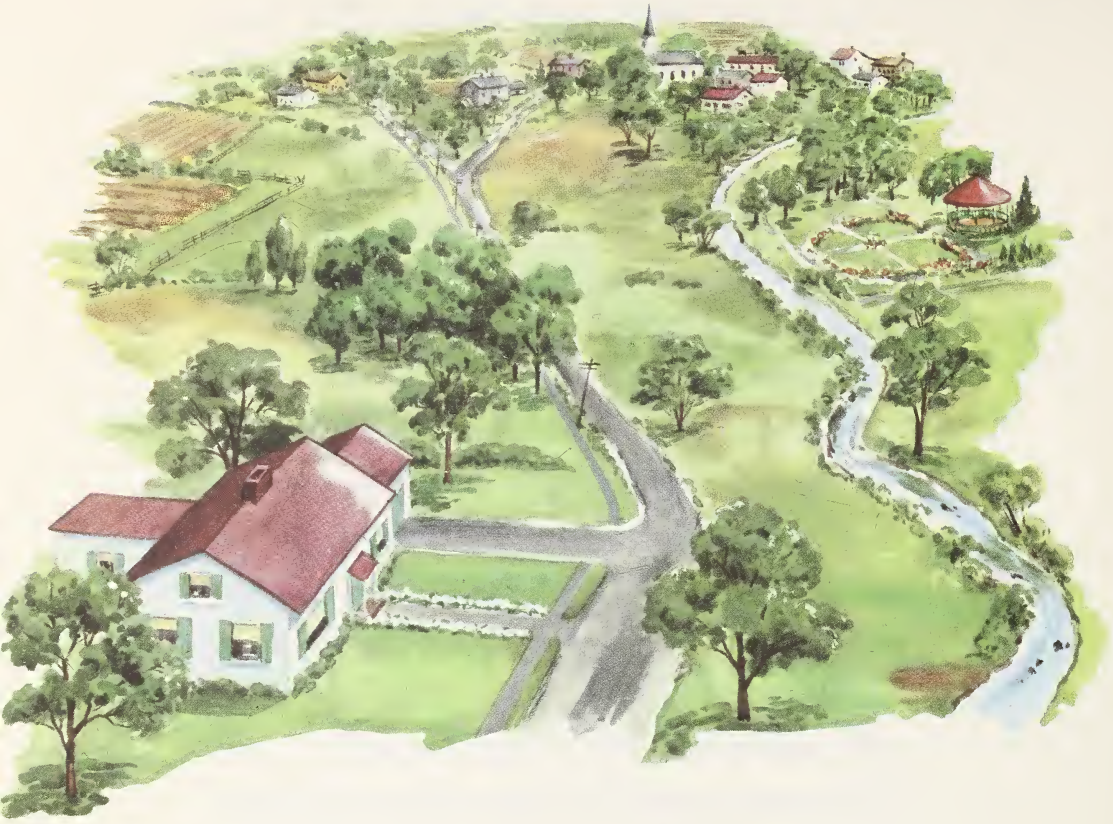


In Ann's town some people have been careless about the way they use the water in the ponds and brooks. They have not taken care to keep the brooks clean. Often they put paper and garbage into the ponds. Because the paper and garbage are dirty, the water does not have a pleasant smell.

It is not safe now for Ann or anyone in her town to drink water from these ponds or brooks. It is not safe, because the people have been careless. Perhaps the time will come when the brooks will be clean again. Then the people in Ann's town can enjoy the brooks and ponds once more.

Is there a pond or brook where you live? How does it look? If the water is dirty, how did it get so dirty? Were some people careless where you live? What can you do to help to keep your ponds and brooks clean?





Clear Creek

Susan's home is near Clear Creek. Find Susan's house and the creek in the picture. Do you think it would be pleasant to live near Clear Creek?

Does this water look like the brook where Ann lives?

No one in Susan's town puts paper or garbage into this creek. Everyone is careful not to put paper or garbage in the water.

This water is so clear that Susan can see the pebbles on the bottom when she walks along the bank. The pebbles are not covered with mud or paper or garbage. Many plants grow along the banks.

Many people enjoy Clear Creek. Some of the boys catch fish there. There is a park beside the creek. Susan and her friends like to have picnics in the park. It is pleasant to play beside Clear Creek.

Have you a park such as this in your town?

Do you have picnics in the park?

Sometimes in the winter the weather may get very cold. When this happens, the water in Clear Creek freezes. It changes to ice. Then the boys and girls may skate on it.

The people in Susan's town try to keep the water in their creek clean. Then they can enjoy the creek all through the year.

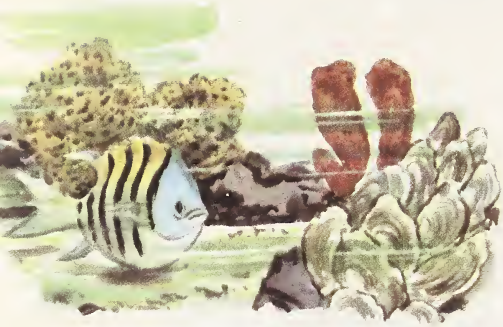
Water for Plants

Plants need water in order to grow. Some plants grow in water. They float about on top of the water as it moves. Other plants grow in the wet soil at the bottoms of ponds and streams. Their long stems grow up through the water. Have you seen plants like the ones in the picture at the right?

Garden plants need water, too. Garden plants get water from the rain which falls. Father sometimes waters the garden when there is not enough rain. Mother waters her flowers.

Sometimes, in places where there is not enough rain, water is brought from far away. The water is put on crops. Without this water the crops could not grow.

Water for Animals



Many animals make their homes in the waters of the earth. Fish, oysters, and sponges are some of the animals which live in the water.

Some animals live near the water and spend a part of their lives in ponds, streams, or rivers. Frogs are such animals. They come out of their eggs in the water and live there until their legs grow. Then they can hop about on land, but they do not go far from the water.

Animals which do not live in or near the water need water, too. Sometimes such animals may come to a water hole to drink. They may live in different places and eat different foods, but they all need water.

Animals need water in order to live. They get water in many ways.

Water for Everyone

How important water is to all of us!

We drink water every day. We take our baths in water. We clean our teeth with water. Our clothes are washed with water. Water is used to cook many of the foods we eat. After we eat, the dishes are washed in water.

We enjoy the water on the earth in many ways.

We like to swim in it. We like to play in the waves along an ocean beach, or splash about in the water of a swimming pool.

We like to go fishing in water. We may fish in a cold, clear mountain stream or perhaps from a boat. We can spend many hours fishing.

Sometimes it is fun to take boat rides on the water.

We enjoy the lakes and rivers and oceans as we travel about the country on trips. We like to look at the splashing waterfalls. Water makes the earth more beautiful.

Water ! Water ! Water ! We use it every day. We could not live without it. We must learn to use it wisely if there is to be enough water for everyone.

Some Things for You to Do

1. For three days keep a list of all the ways you use water. How many times a day do you turn on the water? How often do you get a drink?

2. What animals where you live make their homes in the water? Make a list of these animals.

3. Paint or draw your own pictures showing many different ways that people use and enjoy water.

4. Draw pictures for a class book showing how animals and plants use water.

5. Find out where you get the water you use. Does it come from a lake, a water tank, or some other place? How does this water get to your house?

6. Talk with the other children in your class about the things you can do to keep the ponds and brooks in your town clean.

7. Talk with your class about how you can use water wisely.

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